The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

MAY, 1927 · VOL. 12, No. 5

$3.00 per year in U. S. · 608 S. Dearborn St., Chicago, Ill. · $4.00 per year abroad

Now

TYPE "F"

GE WELDING ELECTRODE

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for use on cast iron.

TYPE B
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TYPE F
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550-13

GENERAL ELECTRIC

MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT

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Foster-father of welding

IT IS no small honor to be chosen as a Linde service man. These operators and engineers have proven themselves by practical welding ability, by capacity to instruct others in the art, by solving problems of production, maintenance and repair and by tactful organization work.

Only picked men could handle the problems they meet. And even these could not do so without years of experience in the field.

This staff of service men has seen welding and cutting technique develop from small beginnings to a fundamental process of production, construction and maintenance in American industry. They have helped new processes to grow and they themselves have often discovered and developed new applications.

They are truly the foster-fathers of welding.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
General Offices: Carbide and Carbon Building
30 East 42d Street, New York

37 PLANTS . . . . . 107 WAREHOUSES

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AIRCO OXYGEN IS 99.5% PURE IN THE CYLINDER

The Purest Oxygen Is Always the Most Economical

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AIRCO

ACETYLENE
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19 DISTRICT OFFICES

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The final cost of oxwelding

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It is not possible that one gas company after another should have adopted oxwelded pipe lines unless there were both economy of installation and economy of upkeep. Plant after plant would not have standardized on oxwelded tanks and welded equipment if it were not sound operating policy. Thousands of engineers and operating executives sponsor the oxy-acetylene process by using it.

The final cost of the gas-welded joint, because of its greater ruggedness, longer life and elimination of maintenance, is always lowest.

Prest-O-Lite

DISSOLVED ACETYLENE

22 years old and still growing

THE PREST-O-LITE COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
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30 East 42d St., New York
31 Plants—101 Warehouses

The Welding Engineer

Founded by L. B. Mackenzie, 1916

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Save Delays by Keeping Posted

IT ISN'T surprising to find that a purchasing agent has difficulty in keeping up with new lines, but a dealer should make it his business to know what is on the market. Along came one recently in great haste to learn the address of the maker of an item that is rapidly becoming popularized through advertising. It was easy to furnish full information—simply a case of clipping a current advertisement. This dealer's customer was probably a reader of *The Welding Engineer*, and knew his stuff better than the man who was selling him. The dealer should have had the information on his desk and saved the delay of writing for it. Perhaps the reason some customers are "hard boiled" is just because they read and keep up to date. It is a fact, that busy executives attach great value to the advertising pages of business papers, knowing that they furnish contacts with the leaders of industry, and read them regularly so that progress will not get ahead of them.

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G. H. Mackenzie.....President and Treasurer
M. J. Hungerford.....Vice-President
H. S. Card.....Secretary

H. S. Card.....Editor
H. P. Ritsch.....Associate Editor

Eastern Office—312 American Circle Bldg., New York
T. E. DePew, Eastern Manager
Telephone, Columbus 6941

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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SOUTH AFRICA—J. W. Arnison, 35a Victoria Ave., Benoni, Transvaal South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co

ACETYLENE CYLINDERS
Keith Dunham Company
Pressed Steel Tank Co.

AIR LIQUEFACTION OXYGEN PRODUCING PLANTS
Keith Dunham Company
Heylandt Sales Co.

ALUMINO-THERMIC WELDING
Metal & Thermit Corporation

ALUMINUM SOLDER
Weldene Corporation

ANNEALING FURNACES
General Electric Co.
Westinghouse Elec & Mfg. Co.

APRONS (Asbestos)
Ideal Face Shield Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BLOW PIPES
See "Torches."

BOOKS
The Welding Engineer Pub. Co.
Electric Arc Cutting & Welding Co.

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Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Alexander Milburn Co
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Williams & Co.

BRONZE FILLER RODS
American Brass Co.
Central Steel & Wire Co.
Steel Sales Corp.

BUFFERS
Mall Tool Co.
N. A. Strand & Co.
Wodack Electric Tool Corp.

BUTT WELDERS
See "Electric Resistance Welders"

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

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Air Reduction Sales Co.
National Carbide Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBIDE (Compressed in Cakes)
Carbic Mfg. Co.

CARBON (Blocks, Paste, Electrodes, etc.)
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Electric Arc Cutting & Welding Co.
Harris Calorific Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co.
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Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

CAST IRON SOLDER
Weldene Corporation

CONSULTING ENGINEER
E. F. Hollinger

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Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
National Carbon Co.
Una Welding and Bonding Co
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CYLINDERS (Acetylene)
Keith Dunham Company
Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Wm. Wharton, Jr. Co.

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N. A. Strand & Co.
Wodack Electric Tool Corp.

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Electric Welding Machine Co.
General Electric Co.
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Gibb Welding Machines Co.
Lincoln Electric Co.
E. A. Lundy Co.
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Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
R. D. Thomas Co.
Una Welding and Bonding Co.
Waters Arc Welding Corp.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
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Goodman Electric Machinery Co.
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R. D. Thomas Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
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Chicago Steel & Wire Co.
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General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corporation
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Lincoln Steel Co.
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Page Steel & Wire Co
Quasi-Arc Weldtrode Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Standard Steel & Wire Co.
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Stulz-Sickles Co.
R. D. Thomas Co.
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Waters Arc Welding Corp.
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Williams & Co.
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Burke Electric Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Mattice Engineering Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Seneca Electric Arc Welder Co.
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Una Welding and Bonding Co.
Waters Arc Welding Corp.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE TIPS (Resistance Welding)
Elkon Works, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Mattice Engineering Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Strauss & Buegeleisen
R. D. Thomas Co.
Una Welding and Bonding Co.
Waters Arc Welding Corp.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

FILLER RODS
Air Reduction Sales Co.
American Brass Co.
Central Steel & Wire Co.
Craftsweld Equipment Co.
Oxweld Acetylene Co.
C. H. Hollup Corp.
Imperial Brass Mfg. Co.
Lincoln Steel Co.
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stulz-Sickles Co.
R. D. Thomas Co.
Torchweld Equipment Co.
Wickwire-Spencer
Welding Service Co.
Weldit Acetylene Co.
Williams & Co.

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Joseph Dixon Crucible Co.
National Carbon Co.
U. S. Welding Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Anti-Borax Compound Co.
Carbic Mfg. Co.
Metal & Thermit Corp.
Central Steel & Wire Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Weldene Corporation
Weldit Acetylene Co.

GAS SAVING DEVICES
Harris-Calorific Co.
U. S. Welding Co.
Weldit Acetylene Co.

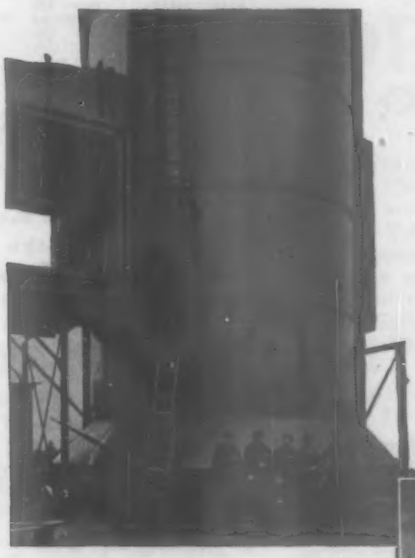
GLOVES (Asbestos)
Ideal Face Shield Co.

GAUGES
Moto Meter Co.
National Gauge & Equipment Co.

GENERATORS (Acetylene)
Air Reduction Sales Co.
Carbic Mfg. Co.
Craftsweld Equipment Co.
M. Keith Dunham
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
U. S. Welding Co.

GOGGLES
Chicago Eye Shield Co.
Ideal Face Shield Co.
Strauss & Buegeleisen
Willson Goggles, Inc.

GRAPHITE (Rods, Blocks, Paste, Etc.)
Joseph Dixon Crucible Co.

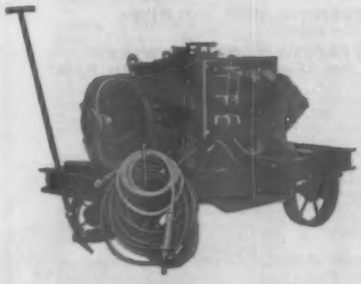


One of the seven arc-welded stacks at the Edison Plant, 14th Street and East River, New York. Height of each stack: 256 feet above roof; diameter: 22½ feet.

At the
New York Edison Plant
14th Street and East River

Interior of a stack, showing arc-welded seams.

1½ Miles
of arc-welding in each stack —*every inch a Wilson Weld*



The above is a Wilson Type S Single-Operator Motor-Driven Electric Welding Machine—designed for both production and repair work, and adapted for use wherever power is available. Its capacity is 25 to 300 amperes. Other Type S Machines include both single and two-operator units—gasoline-engine-driven, belt-driven and motor-driven—portable and stationary. Capacities: 25 to 250 Amps., 25 to 300 Amps., 25 to 600 Amps.

When the power house of the New York Edison Co., at 14th Street and East River, New York, is completed, each of the seven stacks that tower above the roof will contain 7,500 feet (1½ miles) of arc-welding—a total of nearly 10 miles—one of the biggest welding jobs ever attempted!

And every inch of the 1½ miles of welding in the stack pictured above was made with Wilson Welding Machines and Wilson "Color-tipt" Welding Wire—Grade No. 17 (patented U.S.A., June 13, 1916; March 9, 1920) diameter 5/32", at 150 amperes. The third of the seven stacks is now in process of construction.

In addition to the 52,500 feet of welding in the seven giant stacks, the seams on the horizontal flues between the stacks and in the cinder catcher are being welded, and all rivets welded over as protection against corrosion from the acid fumes that form in the cinder catcher. The rivets are being welded over with Wilson Grade No. 0. The seams are being welded with Wilson Grade No. 9 (patented U.S.A., June 13, 1916; March 9, 1920) diameter 5/32", at 145 amperes.

This phenomenal welding job at the Edison Plant is another illustration of the adaptability of Wilson Wire to practically every welding problem. No matter what industry you are in, there is a grade (analysis) of Wilson "Color-tipt" Welding Wire that will meet your own particular welding needs—and there is a Wilson Welding Machine that will meet your own particular operating conditions.

Write today for a sample of Wilson Wire—just indicate the kind of metal you desire to weld. Also, ask for bulletins describing Wilson Welding Machines.

WILSON WELDER & METALS CO. INC., WILSON BUILDING, HOBOKEN, N. J.

WILSON

WELDING MACHINES AND WELDING WIRE

GRINDERS (Portable Electric)
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Electric Welding Machine Co.
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General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Mattice Engineering Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Weldtrode Co.
Seneca Electric Arc Welder Co.
Strauss & Buegeleisen
R. D. Thomas Co.
Waters Arc Welding Corp.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

HOSE COUPLINGS
Carl A. Norgren Co.
See also under "Needle Valves"

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

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International Oxygen Co.
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Modern Engineering Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Weldit Acetylene Co.

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Modern Engineering Co.
Oxweld Acetylene Co.
Stevenson Distributing Corp.
Torchweld Equipment Co.
U. S. Welding Co.

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Carbic Mfg. Co.
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Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
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Oxweld Acetylene Co.
Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

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Wilson Welder & Metals Co.

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International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
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OXYGEN
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International Oxygen Co.
Linde Air Products Co.

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Keith Dunham Company
Heylandt Sales Co.

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Metal & Thermit Corp.

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Una Welding and Bonding Co.

RAIL JOINT WELDERS
Una Welding and Bonding Co.

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N. A. Strand & Co.
Wodack Electric Tool Corp.

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International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Welding Service Co.
Weldit Acetylene Co.
Williams & Co.

SEAM WELDERS
See "Electric Resistance Welders"

SPOT WELDERS
See "Electric Resistance Welders"

TANK CONNECTIONS
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Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

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Metal & Thermit Corp.

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Imperial Brass Mfg. Co.
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K-G Welding & Cutting Co.
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Oxweld Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.
Welding Service Co.
Weldit Acetylene Co.
Williams & Co.

TRUCKS (Cylinder)
Air Reduction Sales Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Torchweld Equipment Co.

VALVES
Air Reduction Sales Co.
International Oxygen Co.
Kerotest Mfg. Co.

WELDING COMPOUND (for Shape Welding)
Air Reduction Sales Co.
Harris Calorific Co.
Joseph Dixon Crucible Co.
Modern Engineering Co.
National Carbon Co.

WELDING ROD HOLDERS
C. Sorensen

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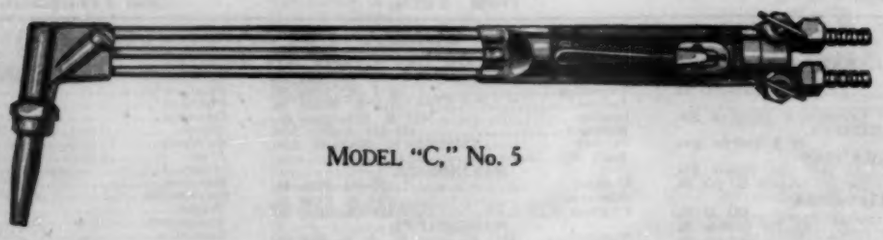

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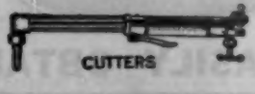

To the WELDING INDUSTRY

WE HONESTLY BELIEVE THAT

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ARE THE FINEST QUALITY RODS ON THE MARKET TODAY

WE manufacture bare electric welding rods of both Pure Iron and Mild Steel analysis. We do not recommend bare rods for electric welding. We believe that the manufacture of a good electrode only starts with a bare wire. However, as large quantities of bare electrodes are used throughout the country, we supply them to those who desire this class of material.

We believe our oxy-acetylene welding rods are the most perfect rods of this type on the American market. They are manufactured from steel and iron made expressly for the purpose. These wires are drawn and copper coated under the direct supervision of our Wire Drawing Superintendent, who has been drawing this type of wire for twenty-five years in France, Italy and Switzerland. The extremely high quality of material used and finish make it a pleasure to use "RACO" gas welding rods.

For electric welding we recommend Raco Composite Electrodes. These rods are used equally well with either A. C. or D. C. current. This rod was originally developed for automatic welding where bare wire will not function due to great speed in welding and high amperage used. The Composite Rod is recommended for all work where bare and covered electrodes have previously been used. Greatly increased speed and far better penetration is secured and absolute uniformity of rods throughout an order is absolutely guaranteed. A special flux of truly wonderful characteristics is inlaid in the lengthwise grooves the entire length of the wire. The flux is protected in the grooves and cannot chip out, even when the wire is bent flat against itself. The accurate depth of the grooves automatically regulates the correct amount of flux needed.

The Composite Wire is furnished on reels for automatic arc welding and will give perfect results under special conditions of high speed and high amperage. The flux in the grooves contains a high percentage of titanium and will weld Cast Iron with better results than any electrode on the market today.

Our Company specializes in drawing welding wire only. We have no other interests and can give our welding rods our undivided attention.

Raco Welding Rods are fairly priced and we are able to give real service from our new plant at Dundalk, Maryland.

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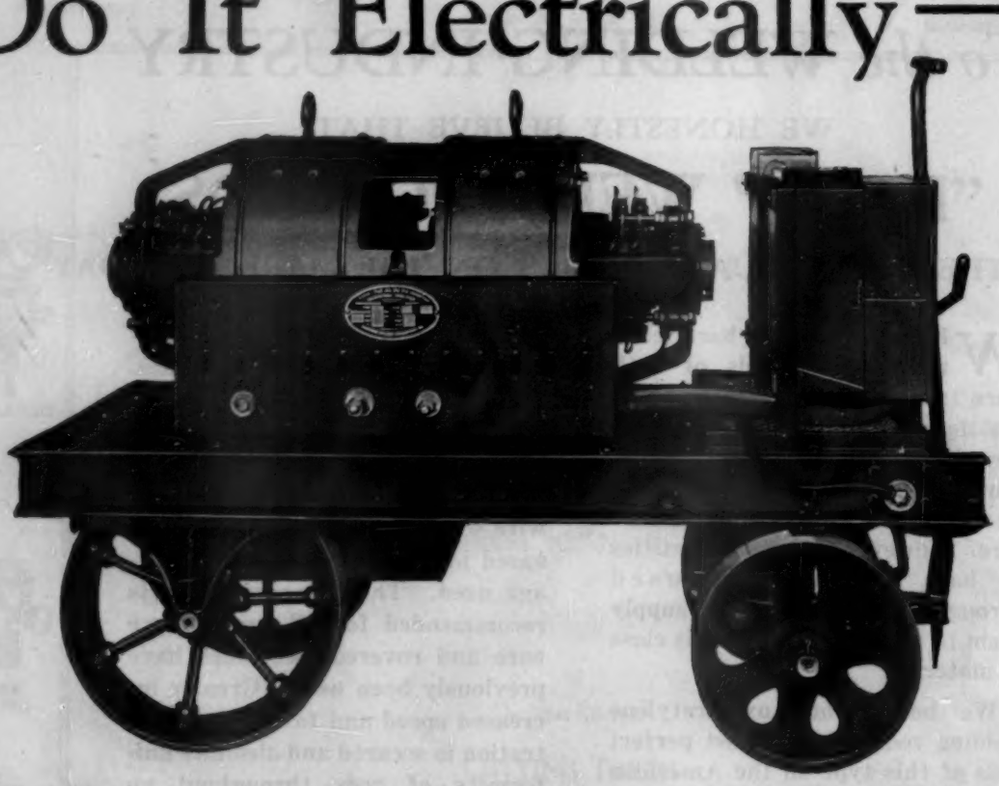

Not Merely Another Arc Welder—But a Better Arc Welder

The Mann Master Controller

The Mann Master Controller besides being incorporated as one of the main features of the Mann Master Welder, can also be furnished as a separate unit to users of other types of welding equipment. All that is necessary is to insert it in the welding lead from the machine to the work and all of the main benefits claimed for the Mann Welder will be obtained.

These Comparative Operating Charts Prove It

CHART A. Graph of widely used constant current welder, showing arc restlessness customary in "all machines.

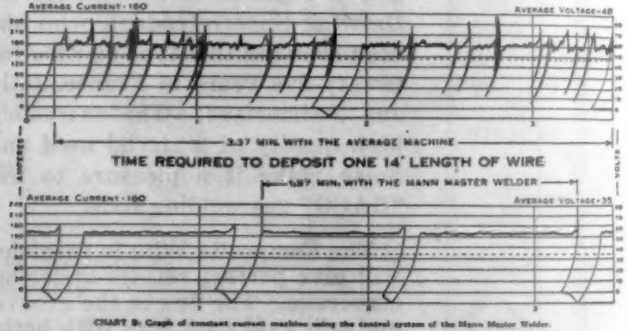

CHART B. Graph of constant current machine using the control system of the Mann Master Welder.

What the Mann Master Welder Saves—

Time required by machine in Chart A to deposit one 14" length of wire	**3.37 min.**
Time required by Mann Master Welder to deposit one 14" length of wire	**1.87 min.**
Time saved by Mann Master	**1.50 min.**
Corresponding to a Time Saving of	**44.5%**
Power required by machine in Chart A (160 amps. x 48 volts) x 3.37/60 hr.	**432 watt hrs. per wire**
Power required by Mann Master Welder (160 amps. x 48 volts) x 1.50/60 hr.	**140 watt hrs. per wire**
Power saved by Mann Master Welder	**292 watt hrs. per wire**
Corresponding to a Power Saving of	**67.6%**

Result

TIME SAVED · POWER SAVED · OPERATOR SATISFACTION

the Mann Master Welder!

a Better Weld, in Faster Time, at Lower Cost—

FIFTEEN years of study and specialization is behind the advanced design of the Mann Master Welder. It fully meets a long felt need in the welding industry for an easier, more flexible arc of more uniform heat, a greater current range, an accurately controlled temperature and a deeper penetration.

The remarkable flexibility of the arc permits the operator to master the most intricate welding jobs, heretofore, considered impractical. The ease of striking and maintaining the arc under all conditions is made possible by the wide current range varying from the rated capacity down as low as 10 amperes.

This opens up a new field in the thinner gauges of sheet metal, it being possible to weld metal .022 in thickness with perfect success. The welding of chrome alloys and spot welding is also made possible as well as greatly improving the welding of non-ferrous and carbon metals.

The Secret of Its Remarkable Performance—

—Is the unique current control system which automatically maintains the current perfectly smooth and uniform, eliminates arc explosions and results in a perfect, clean weld far stronger than the average weld.

The wide current range of the Mann Master Welder makes it adaptable to a very broad field. With an emergency step for intermittent cutting at 700 amperes, it will cut through and burn fitting holes up to one-half inch plate without carbon and at a far lower cost than acetylene.

From every view point, the Mann Master Welder is a true masterpiece—worthy of the serious consideration of the entire welding industry.

Descriptive bulletins furnished on request

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National Carbon Products for Electric and Gas Welding Operations

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National Welding Carbon Products are highly refractory and are designed to withstand the extreme temperatures encountered in gas welding operations. National Welding Carbon Blocks, Rods, Paste and Flour are very desirable for all gas welding operations requiring the use of molds, cores or dams for the protection of all parts requiring shielding from the heat of the torch.

For Electric Arc Welding

National Welding Electrodes have been designed especially to meet the requirements of all electric carbon arc welding or cutting apparatus. Whether you work with a large or small current, there is a National Carbon Electrode which will give you complete satisfaction.

There are also National Welding Carbon Blocks, Rods, Paste and Flour for molds, cores or dams in all arc welding processes.

Write us explaining your production problems or construction jobs. The use of National Carbon Products may help considerably in making these operations more efficient. Our sales engineers are at your service.

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FOR a score of years Milburn Equipment has been making history and establishing world's records on large railroads, industrials and government departments.

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The name—MILBURN—on

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Catalog 35F on request

The
ALEXANDER MILBURN COMPANY
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Pop bought "Something just as good"

"Here, Lad . . .

When I told my friend, from whom I bought that new arc welder, that the men were kicking about it and sore because it wasn't a Lincoln—**he was full of scorn** that the men should be so misled. I want you to SELL them on the idea that it's right.

Kathode wire is furnished in the following diameters: 3/32", 1/8", 5/32", 3/16", 1/4", 5/16", 3/8".

Lincoln Shields are absolutely leak-proof.

Here is a holder that will save many minutes of the operator's time. It is a simple, powerful clamp in which the electrode is firmly held.

"Yes, Pop...

and the fellow who points the finger of scorn usually points another at his own perfection. —And you know, pop, that there are very few examples of perfection—and I'm willing to admit that even with arc welding there are few spots where perfection has been reached.—

Take the shop that buys a "Stable-Arc" welder and feels that now they've got the highest type of welder, that perfect work will result. They're wrong because the welder is but the **first** step toward perfection.

The next step must be the BEST welding rod and the next step the best holder. And the next step the best shield.

Best operators will naturally result because a worker given the best tools instinctively feels that the rest of BEST is up to him—AND HE DOES IT.

The Lincoln Electric Co. Dept. No. 27-4
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LINCOLN "Stable Arc" WELDER

Winged Victory of Samothrace

Enduring

The responsibility of a gauge is not a factor to be disregarded. It goes hand in hand with the quality of workmanship on welding operations. For a gauge that cannot be trusted is worth less than no gauge at all.

Natweld Gauges are built around their bronze Bourdon springs. And these springs, rolled of non-corrosive bronze metal by a process that gives them the temper of a Damascus blade, are *enduring*. Therefore Natweld Gauges live up to their responsibilities faithfully.

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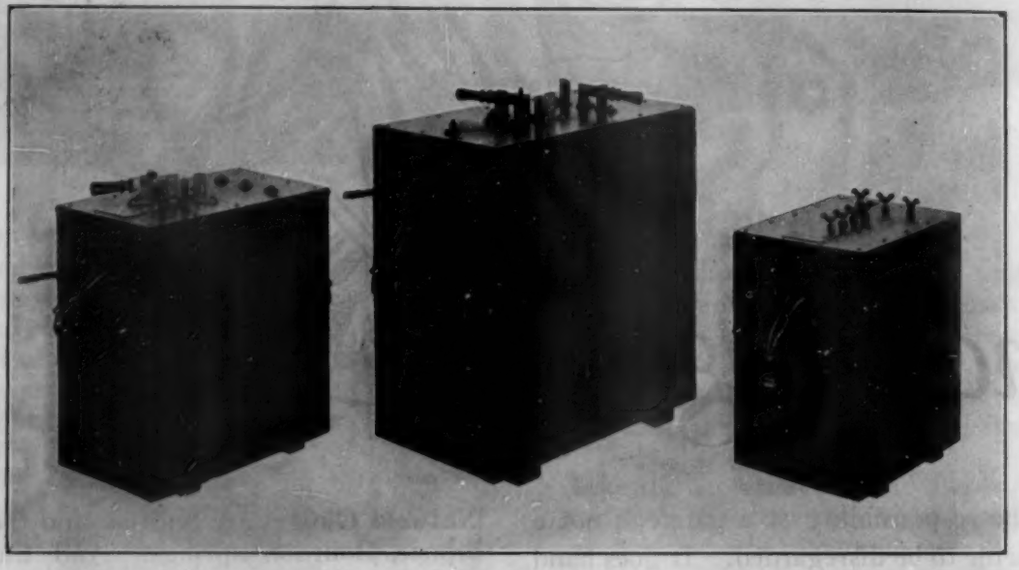
If you were equipped with an

OWEN INDUCTION ARC WELDER

you could weld many jobs that you now believe impossible to repair



TYPE A. H. D.
50 to 200 Welding Amperes
Weight, approx. 290 lbs.
Size, 12″x20″x22″

TYPE U-O
50 to 300 Amperes and up
Weight, approx. 375 lbs.
Size, 14″x24″x26″

TYPE A. M. D.
Equipped with Studs and Nuts Instead of Rotary Switch
50 to 150 Welding Amperes
Weight, approx. 190 lbs.
Size, 12″x18″x20″

Why not solve your welding problems by using the OWEN?

Owen Electric Manufacturing Company
Fayetteville, North Carolina

SWEDOX

WELDING RODS, WIRES and ELECTRODES

SWEDOX Welding Rods and Wires, differing widely in chemical and physical properties, have one common quality. Each brand is made for a particular welding requirement.

When you consider the care that must be exercised in the selection of metal for different construction requirements, it becomes apparent that equal care is necessary in selecting filler material for welding the joints in these constructions.

The SWEDOX line has been developed so as to furnish on each welding job the welding wire which will enable the welder to get the most satisfactory result. There is a SWEDOX wire for your work. Try it, and you'll know why SWEDOX customers come back.

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BUSINESS PAPERS
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The editors pick out of the many phases of the flow of trade, news and policy trend in methods or machinery which will best serve the reader's needs. The advertising pages are a huge many-leaved coupon on the editorial section. And above all, the paper as a whole seeks to express the higher purposes and objectives of the small and large business men it serves.

For as Mr. Swope further said in his fine analysis of industry responsibility in this same address:

"It isn't necessary to be big to be successful, but it is absolutely essential to be successful to be big. You can't grow without that."

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Giant water wheel casing at Parker Young Company's plant after worn section was welded.

Welding Forestalls 11-Week Shut-Down

The Parker Young Company, Lincoln, N. H., was confronted with a serious loss in time and production when a section of a large water wheel casing was found to be too badly worn for continued operations.

An entire new casing was thought necessary. This would cost approximately $1,000 and delivery could not be promised for at least three months.

Arc welding, with 200 ampere Westinghouse single operator unit was suggested. The result was—

The repair job cost only $200.

The job was skilfully completed within a week's time.

The plant was kept working when a delay of approximately eleven weeks in production seemed certain.

The saving on the first job practically paid for the machine.

—and gave these Additional Advantages

The repair job cost only $200.

The job was skilfully completed within a week's time.

The plant was kept working when a delay of approximately eleven weeks in production seemed certain.

The saving on the first job practically paid for the machine.

These are just a few facts on the value of the Westinghouse welding equipment for production welding and machinery maintenance. There is a Westinghouse branch office near you which will tell you how this sturdy, easily operated arc welder will make money for you.

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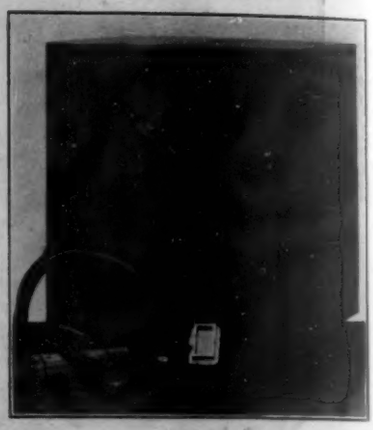

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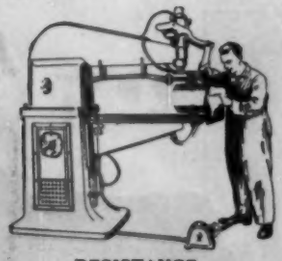

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Fifth Edition

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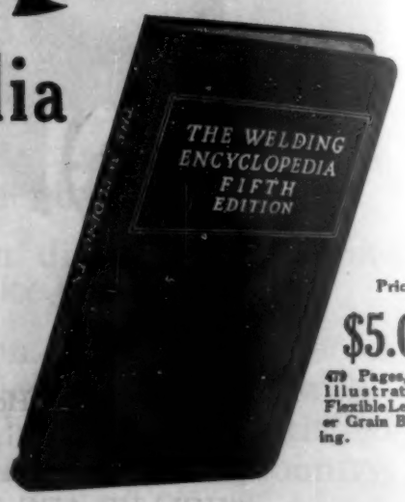

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EDITORIAL

Titles Don't Make Engineers

ENGINEERS and people who use and pay for engineering service have both been sufferers from the work of the bootleg variety of correspondence schools. The success of the better grade of correspondence schools has led many men with more advertising than engineering or educational ability to set up in correspondence school work with policies that divided interest only between sales and profits. They do not hesitate to promise ridiculous salaries or incomes to their graduates, before whom they dangle the promise of a diploma conferring some sort of an engineering degree. Genuine engineers have become greatly concerned about the activities of this sort of correspondence school training. They have recently started a movement to co-operate with the better class of correspondence schools, to get rid of this nuisance if possible. This recalls the many discussions which have been carried on regarding the title of welding engineer. This title may have been abused to some extent by those who have conferred it upon themselves but probably not to any great extent and probably not with any really harmful results. There is always the possibility that welding will gradually earn increased recognition so that engineering courses of the future will provide very thorough training in the theory of fusion welding, and that engineering schools will see fit to give the subject sufficient attention so that men specializing in it may upon graduation receive a degree of welding engineer and be able to feel that the title means something. The use of such a title at present by men obviously unfit to use any kind of an engineering title should be discouraged, so that later on there will not be an undesirable cloud upon it. A thorough knowledge of welding is one thing and a thorough knowledge of engineering something else; it takes both of them to make the complete combination. A man who is an expert welder should not have to lay claim to additional qualifications in order to find a market for his services, because there is still a good deal greater demand for expert welders than can be supplied. Very few people expect an expert welder to have the additional qualification of being a thoroughly trained engineer. Those who really can qualify for the combination deserve to have the exclusive use of the title.

No Monoply on Nutty Restrictions

WELDING on steam boilers seems to have enjoyed a greater freedom from restriction in France than in this country up to this time, but recent reports indicate that the welding industry in that country is faced with a situation quite similar to that on which the welding fraternity in America of late years has been doing some very effective work. According to these reports some measures are being taken for restriction on the use of welding for steam boilers. It is interesting to note that these restrictions are directed against the process itself. It is also interesting to note that these recommendations have been inspired or at least supported by glaring examples of poor workmanship on the part of welders. French welding engineers are faced with the problem of proving that a weld of very poor design, that has been very poorly prepared, and executed in such a shoddy manner as to secure practically no penetration, is not a good example, or even a fair example, of good boiler welding practice. They have our sympathy.

Economy on a Large Scale

ONE explanation of the slow start that welding has made in the field of steam fitting may be that the economies have so often been pointed out on single units only, so that the sums saved looked small compared to the cost of a welding outfit. A story is told of a contractor who looked at it this way, and to his sorrow. His competitor underbid him $25,000.00 on a single job by figuring a welded system, and delivered a better pipe installation. Then he bought an outfit.

Hard Facing

A FIELD for fusion welding which seems to be developing with great rapidity and success is the hard facing of metal parts subjected to severe wear. Leaving welding out of account there is a choice between surface hardening and using an expensive hard alloy for the entire part. Both of these choices are unsatisfactory in a great many cases. Welding first appeared to fill the great gap by joining a piece of hard metal to a piece of soft metal. It was an improvement but left enough to be desired so that experimental work went forward to find a better process. Successful efforts at building up worn manganese frogs, crossings and dipper teeth, and repairing battered rail ends formed the next step in this important field. More recently have come reports of making cutting tools and other parts of like nature more serviceable by fusing on a layer of hard alloy. Specific applications of the principle are multiplying rapidly, and its economic advantages are sometimes spectacular. In the oil industry, for example, the hard facing of fishtail bits has become a standardized and regular procedure. When a hole has gone down three thousand feet it costs a tidy sum to pull up the bit and replace it for the sake of going down another ten feet, and proper facing of the bits will make this extra expense unnecessary. Now the trend is toward using the hard facing process to make new bits. Considered, then, in the classification of production welding its possibilities for volume in this one industry alone are enormous. But there are other industries in need of this same process. Manufacturers of nearly all alloys are experimenting with the different welding methods because they know that their products are so expensive that the consumer must be taught how they may be used sparingly, especially in production. The subject deserves the attention of all manufacturers of welding equipment and materials. It should not be difficult, for every use for hard facing as a repair ought to suggest its use in production, on the theory that it is better to eliminate wear than to repair the worn part.

Redesign Engineering

THIS seems to be a hard term to define briefly unless it be understood to be self defining. It has a profound importance, however, to the man who contemplates using a welding process for production. Welding is different from other methods of joining metals and any extended program of welding must take all the differences into account. The design of any mechanical joint, for example, may need to be entirely changed in order to prepare for the strongest and most economical weld. Also, a slight change in the specification of the metal to be welded may reduce the labor charge and the cost of filler rod, and still not call for a more expensive metal. For example, the use of standard instead of extra heavy pipe for welded lines reduces the cost of every factor in the installations, and costs less. Lighter members can very often be used where welding replaces riveting. So new materials need not mean more costly materials. The point has been well made that welding is not a substitute for anything. It is a process by itself, and where it is used in production old designs should go into the discard so that new ones may utilize welding to the utmost advantages.

Flying Rivals Welding in Safety

IN THE current number of the Annals of the American Academy of Political and Social Science, the second assistant postmaster general notes that the air mail service has flown approximately 2,500,000 miles since there has been a serious accident in the service. Flying is becoming almost as safe as welding, and a contributing factor of no mean importance is that welded joints have improved air plane construction.

Oxweld equipment is not built for stunts

TRICK STUNTS may sell equipment—once. But Oxweld equipment has been made and sold for fourteen years (since the beginning of the welding era) and it is going to be made and sold for years to come.

Oxweld won't make or sell equipment that is built just for stunts that have no real bearing on the actual use of the equipment. Oxweld equipment is designed for efficient service.

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WELDING AND CUTTING APPARATUS

Arc Welding Structural Steel*

Through the Use of Welded Joints Many Steel Structures Can Be Made Stronger With Less Material and Less Labor

By F. A. Marsh†

FOR several years welding and structural engineers have been attracted by the possibilities of welding as applied to structural steel. Much progress has been made and good results achieved by use of welding in such fields as steel barge and ship building, locomotive repairs, pressure vessels, etc. It seems to these engineers that surely the structural steel and steel bridge industries could also benefit by the application of the welding processes to joining of structural members and also in the construction of such pieces as trusses, plate girders, etc.

Should the welding process prove successful, some of the apparent savings are:

Elimination of a very large part of the labor of preparing shop details. (It is now necessary to make elaborate drawings showing each rivet and hole.)

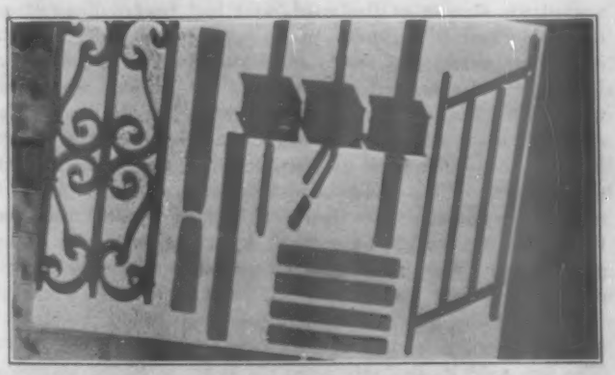
Elimination of all, or nearly all, templets; laying out; punching and riveting in the fabrication shop, substituting in their place cutting materials to length; assembling and welding.

Elimination of noise of riveting guns in the field.

Cutting down the size of erection crews because a single welder would replace each of the present riveting gangs of three or four men.

Lastly, and very important, a very material saving of weight of steel in the design and details.

In designing tension members and tension sides of girders no deduction need be made for rivet holes. All angle legs on girder webs and other similar pieces which serve only as the means of attachment by riveting can be omitted.



Structural Test Pieces and a Sample or Two of Ornamental Iron Work.

Advantage can be taken of continuity of beam action through columns.

Very material savings in connections, splices, etc., can be effected.

Some buildings have been built and much experimental work done.

You may recently have seen an account of the letting of a contract for a five-story steel skeleton building of the Westinghouse Electric & Mfg. Co., at Sharon, Pa., to the American Bridge Co. This building contains about 790 tons of steel, shop and field welded. It is stated that about 100 tons of steel were saved in the design because of the use of welded construction.

Examination of the data collected during a recent series of tests shows that the tests fully demonstrate the following facts:

Welded Ornamental Iron Work is More Attractive and Also More Durable.

1. That welded joints can be constructed in such manner as to develop fully the ultimate strength of the structural members connected.

2. Beams and girders can be connected to columns so as to produce absolute fixation.

3. Lines of beams or girders can be connected so as to provide complete continuity across the supports, whether the supports be girders or columns.

4. That a steel I beam of given section and length will sustain a far greater load if fixed at its ends by a suitable designed welded joint than if supported by standard riveted connections consisting of top and bottom angles. A 9-inch standard I beam, framed between rigid upright columns 8 inches apart by means of specially designed welded connections, sustained a load 35 per cent greater than a beam of the same size and length framed between columns by means of riveted top and bottom angles of ½ inch thickness.

5. A plate girder assembled by welding and consisting of nothing but sheared plates has a far greater bending strength than riveted plate and angle girder of the same weight, due to the better distribution of the steel in the cross section. A 15-inch plate girder assembled by welding and simply sup-

*Abstracted from a paper read before Nebraska Chapter of American Institute of Architects, April, 1927.

†Paxton and Vierling Iron Works, Omaha, Neb.

ported on a 14-foot span, developed more than 50 per cent greater strength than a riveted plate and angle girder of the same depth and the same weight.

A double angle tension member such as is used in trusses was connected at the ends by welding, and when tested to tension failure broke through the angles at a load 30 per cent greater than the load at which a hanger, consisting of the same size angles with riveted end connections, failed.

The prevailing impression among the witnesses was that these tests demonstrated the superiority of welded connections to riveted connections in every case where direct comparisons were made and brought out two general facts:

1. That complete continuity of lines of beams can be obtained in welded construction; whereas it is well known that this cannot be done in riveted construction.

2. That in a welded building, it will be possible to make every joint develop full strength of the main members; whereas in a riveted building, many joints are weaker than the members due to the weakening effects of the rivet holes and the weakness of steel angles which have to be used for transmitting tension between two members at right angles to each other.

How the Author's Firm Advertised Arc Welding During a Recent Pageant.

It was proved that a welded plate girder was 50 per cent stronger than the riveted girder of relative depth, length and weight.

A description of the building welded last winter at Sharon, Pa., for the Westinghouse Electric & Manufacturing Company will be of interest.

The building is 70'x220' in plan and 80' high, with five stories and mezzanine, but no basement. Its construction comprises the welded steel skeleton, splined wood floors and 8" brick walls carried by the steel. Columns divide the plan into 33 panels 20'x23'. The floor live load is 200 lbs. per sq. ft. for girders and columns, but 300 lbs. for beams to allow for special concentrations and suddenly applied loads. The working stress for bending in beams and girders is 18,000 lbs. per sq. in. The same base stress was used in proportioning the columns, with reduction for length,

$$18{,}000 - 80 \frac{R}{L}$$

The American Bridge Company assigned one of its fabricating shops at Ambridge exclusively to the shop welding on this job and installed there Westinghouse welding equipment to serve sixteen welders. As much as possible of the welding was handled in the shop. Shop welding included all assembling of built-up columns and girders, welding of outrigger lintels to beams and welding of seat angles to columns. All beams and girders were milled to length in order to facilitate field welding by providing predetermined end clearances. All columns were milled to bear.

Two holes were punched in the bottom flange at each end of every beam or girder for erection bolts; corresponding holes were punched in seat angles. Likewise four holes were punched near the bottom of every column (except in bottom tier), corresponding to holes in splice plates welded to the column below. The erection bolts enabled the erectors to proceed in the usual manner, except more wire rope was used to hold members in position than ordinarily.

The welders, who numbered not more than sixteen at any one time, did most of their work from small, portable scaffolds slung from the girders. Each welder had an individual welding cable extending from his electrode holder to the welding machinery housed on the ground floor. No helpers were employed; the welders moved their own scaffolds, cables and electrodes. The field welding machinery consisted of ten Westinghouse motor-generators, nine single-operator units of 200 amp. rating and one multiple-operator unit of 1,000 amp. rating with resistance boxes to serve seven welders.

All welding operators employed on shop and field work received special training in the Westinghouse welding school before working on the job. Several of those selected for training were dropped without being used on actual construction. Of those found dependable, the most expert were used on the most difficult joints. Great care was given to close supervision and systematic inspection of welds and occasional welds which were considered doubtful were cut out and done again.

Some useful information was obtained from some test specimens prepared by the Nebraska & Iowa Steel Tank Co. and ourselves and broken by Mr. Pflaster, of the Union Pacific Laboratories, in their 100,000 lb. machine. The first specimen is four pieces of plate which were originally two plates 6x¼x12" welded. This piece was welded by the Nebraska & Iowa Steel Tank Co. for me, after their Mr. George had told me of one of his experiences in selling welded tanks, in competition with riveted work. He made a piece as described and had a shear cut made across both ends to expose the section of the weld. His customer turned the piece over and over, examining the section closely. Finally he said, "You never welded this; you just ran a bead top and bottom on a flat plate." After Mr. George had a piece welded for me, I took it to our shop and sheared it into four pieces across the weld. It seemed to me that the shear cut obscured the section of the weld, so I had two of them planed on both edges. The union of the weld metal and base metal is almost perfect and seems to almost form continuous fibre.

The second specimen is of 2½x⅜" flats welded with a butt weld. This specimen was made to show Mr. Brayton, bridge engineer of the Union Pacific R. R., the operation of our Westinghouse machine. After welding, we decided to try the strength of the weld. We adjourned to the U. P. R. R. testing laboratories and their Mr. Pflaster pulled the piece for us. The break is about 5" from the weld. It was a perfect cup break. The breaking load was 56,500 lbs., or practically 60,000 lbs. per sq. in. elongation 28%.

At the same time, we broke specimen No. 3. This is a ¾" Φ rod pointed and welded top and bottom to a 4" beam. The top weld broke loose from the beam at 25,250 lbs., or, in other words, the rod was being stressed to about 56,000 lbs. per sq. in. when the weld let loose.

At a later date we prepared three other specimens and had them broken in the testing machine. Briefly, these are a 2x⅜" flat bar with weld ground flush. This weld pulled in two at 40,370 lbs., equal to 53,827 lbs. sq. in. Elastic limit, 29,000 lbs.

(5) Two 1¾x⅜" flats welded in the plane of the web of a 4" channel. The weld pulled loose at 32,780 lbs., equal to a unit stress of 49,170 lb. sq. in., elastic limit, 24,000 lbs.

(6) This specimen was devised to give further test like No. 3. Two ¾" Φ rods were butt welded top and bottom in line with the web of a 4" beam. The first break came in the rod 4½" from the weld at 22,920 lbs., of 52,100 lbs. per sq. in. Examination of the break discloses flaws in the

material. In fact, the fibre shows the rod to be not steel but iron, although we bought it for steel. We then put the piece back into the machine and made another pull. The short piece on the side where the first break occurred pulled out of the collar weld at 23,530 lbs., or 53,300 lbs. sq. in. To make sure that the rod was the same above and below the beam, we put the beam into a vise, sawed the rod in half and after much pounding, which bent the rod about 300° from a straight line, we broke off the top. It also proved to be iron.

May I ask you to note that all these breaks which occurred in welds were at stresses well beyond any safe load stresses ever used in designing.

I might also add that the weld rods used in preparing the test pieces were ordinary commercial rods. The rods which we are now using in our fabricating shop are much higher strength and quality, especially manufactured for structural welding.

For two years we have been welding all sorts of railings, gratings, stairwork, etc., with entire success. The work is stronger, lighter, more graceful, more proof against rusting in the joints.

In our structural shop we weld plate work and such work as double angle lintels, channels with angles on the back and beams with plates attached to the bottom.

You doubtless wish to ask me, "How do you know the welds will hold?" The tests which I have described indicate that good welds can be obtained, but it is also possible to test such structural pieces as I have described in a thoroughly satisfactory manner. There are two generally accepted methods of testing welds: by pressure, or hammering the welds, or, in the case of pressure vessels, by both. In our own case, our instructions are, "Treat them rough; slam them around; sledge the welds; make them break in the shop if they are going to break."

WELDING IN FRANK WIGGINS TRADE SCHOOL, LOS ANGELES

Every visitor to the Pacific Coast from anywhere east of the Rocky Mountains has remarked upon the size, beauty and evident completeness of the educational equipment provided for the training of the youth of this far western portion of the United States. School structures of architectural artistry and magnificent proportions are found throughout the Pacific Coast region. Just as an instance of what she is doing to provide not only mental but manual training for her young people is the recent opening of the Frank Wiggins Trade School. This magnificent building, erected by the City of Los Angeles at a cost of approximately $1,500,000, is designed for the training, not only in the elementary principles but in the advanced practices, of some forty trades and handicrafts. Many of these classes in manual training have been in existence in the Los Angeles schools for a number of years and already possess fairly good equipment. Others are at present in the formative stage, but are acquiring the necessary equipment just as rapidly as possible.

Notable among these latter is the welding department. This is one of the more recent of the trade schools to have been included in the scope of instruction intended at the trade school and has been in existence only since last February. It has both day and night classes, the former for boys just beginning to learn welding and the latter for more advanced students who desire to perfect what they already know about the trade. The school is under the direction of James W. McCartney, who devotes the most of his time to teaching the day classes, while the evening classes are in charge of Daniel G. Davies.

At the present time the equipment of the school is entirely of the oxy-acetylene type, although it is intended to add equipment for electric welding in the near future.

The institution of this school has a large interest for Los Angeles because of the rapid advance in welding which has taken place within the last few years, and because in Southern California in particular, what with its vast number of automobiles and its vast oil development, opportunities for competent welders are increasing by leaps and bounds. Automobile work, pipe welding, pipe repair work, tank building, refinery construction, manufacturing of various kinds, and latterly experiments in welded steel construction, afford the assurance that the future for expert welders is an alluring one.

The instruction work in the Frank Wiggins school is very similar to that conducted in the largest shops and manufacturing plants. The course outlined for beginners is expected to cover six months' work of four hours daily in the shop. In addition to teaching the use of the torch, the course in-

Frank Wiggins Trade School.

cludes expansion and contraction of metals, laying out work, figuring angles and making bends. The student is made acquainted with the properties of different metals, given training in general repair work and also is given instruction in related mathematics. It is presumed that the beginner at the expiration of his six months' intensive training will be able to go out on the job equipped to earn good wages while perfecting himself in the more advanced operations in the trade in actual work.

The foregoing outlines briefly the scope of the designed training for the day classes, while the evening classes are reserved for the more experienced men who desire to avail themselves of the facilities of the school to perfect their knowldge of special kinds of welding operations.

PREST-O-LITE CO. SELLS BATTERY BUSINESS

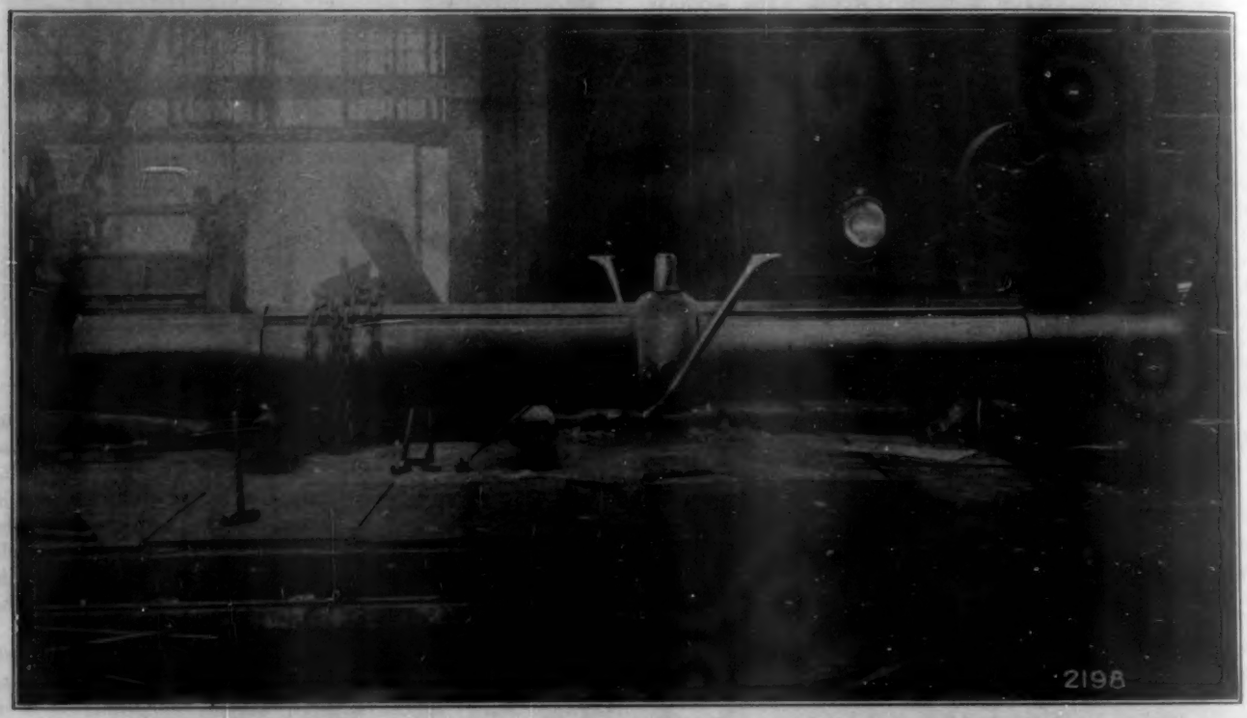
The Prest-O-Lite Co. announces the sale of the storage battery branch of its business to a new company, Prest-O-Lite Storage Battery Corporation. The entire capital stock of the purchasing company is owned by the Automotive Battery Corporation of New York. That portion of the Indianapolis plant of the Prest-O-Lite Co., Inc., used for the manufacture of storage batteries, has been leased to the new company.

The Prest-O-Lite Co., Inc., while discontinuing the battery branch of its business, will continue the manufacture and sale of acetylene gas for use in the oxy-acetylene process of welding and cutting metals, automobile lighting, lead burning, etc. These operations have, in the past, constituted the major portion of its activities. In addition to continuing its acetylene business, involving the operation of thirty-two acetylene plants located in industrial centers throughout the country, the Prest-O-Lite Co., Inc., will continue operation of that portion of its Indianapolis plant devoted to the manufacture of gas cylinders, acetylene generators and other apparatus.

Thermit Welding Practice Improved

New Methods of Design and Procedure Reduce Amount of Materials Used and Improve Quality of the Weld

IN THE steel mill, where it often used to be more economical to replace a broken part, the Thermit welding process has now become so economical that Thermit welding reclamation departments are being organized in plant after plant, and one plant alone of an important steel company employes a large force of men for this work, using almost 100,000 pounds of Thermit per year and is making very large savings. The work is done on all iron and steel sections, including table rolls, rolling mill housings, blooming engine parts, crankshafts, connecting rods, charging peels, etc. A great deal of work is also done, by the use of a special Thermit designated as wobbler Thermit in replacing the wear on wobblers, and the metal can be so accurately added as to require no machining and is so hard as to be just barely machineable and resists wear indefinitely.



Twenty-six-Inch Diameter Blooming Mill Shaft Welded in 48 Hours With Thermit.

The new improved method of making the Thermit weld developed and patented after a very extensive research and which has been in use during the past year is an important economic factor in reclamation work. This new design enables a Thermit weld to be made with less than half the amount of Thermit previously required and this, in turn, permits the use of smaller mold boxes, less molding material, quicker ramming of molds, less labor, and smaller crucibles. The change in the crucible cost is an important item when it is realized that a crucible to contain a steel of over 5000 degrees fahrenheit must be very carefully made and because most of the refractories dissolve to some extent in steel at this temperature, the highest grade, dead burned magnesite must be used. A crucible lining of this magnesite lasts in the case of small crucibles for forty or fifty reactions, but in the case of large crucibles holding 600 or 700 lbs. of Thermit, the lining lasts for only four or five reactions. The new methods have made this crucible problem much less important because in the big welds where two or more crucibles were used, only one is now necessary, and, where one large crucible was previously used, a much smaller one can now be used, the smaller one costing less in the first cost and much less per reaction because of its longer life.

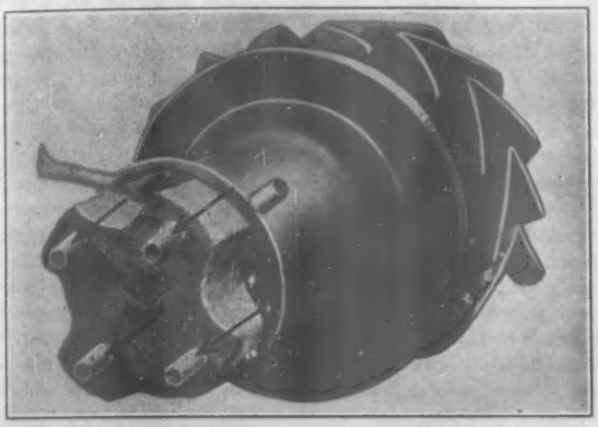
The great saving possible in the new method over the old can be readily appreciated by comparing a typical ther-

A Test Block Showing the Old and New Method of Making the Thermit Weld—Note the Great Reduction in the Amount of Thermit Used.

mit welding operation on an 8 inch diameter shaft as carried out by the two methods:—

	Old Method	New Method
Pounds of Thermit required	155	65
Width of Thermit steel collar	7"	4"
Thickness of Thermit steel collar	1⅝"	⅞"
Diameter of Riser	4½"	2"

The difference in the final costs, which involve the cost of the Thermit, the crucibles and the pounds of wax required in making the mold, shows a saving of approximately 60 percent by the new method. This percentage does not include the items of the smaller amount of molding material used, less labor required and the time saved.



Four Pods Built Up With Thermit Before Machining—During 1926, One Steel Mill Report Showed That Over 200,000 Tons of Steel Were Rolled, With a Pinion of This Description on Which New Ends Were Welded by the Thermit Process.

The Thermit process in its present and highly efficient stage of development offers convincing proof of the great saving possible in reclaiming broken steel mill parts involving heavy sections, and the importance of organizing a reclamation department in the steel mills cannot be denied recognition.

INTERNATIONAL ACETYLENE ASSOCIATION INVITED TO ATTEND BRUSSELS CONGRESS

In agreement with the decisions taken by previous congresses, together with those taken by the Permanent International Committee, appointed by the Eighth Congress, held in Paris in December, 1923, the Ninth Industrial Acetylene and Welding and Allied Industries Congress will be held in Brussels, Belgium, July 5 to 8, 1927.

The work of the congress will be distributed among four sections, as follows:

Calcium Carbide

A.—International investigation as to production, consumption, imports and exports of calcium carbide.

B.—Manufacture of calcium carbide.—National and International Standards.—Analysis and yield measurements of calcium carbide.—Packing and transportation.—Regulations.

C.—Chemical derivatives of calcium carbide and acetylene such as: cyanamide, aldehyde, acetic acid, acetone, chlorine derivates, etc.

Oxygen and Fuel Gases

A.—International investigation as to production, consumption, imports and exports of oxygen and fuel gases.

B.—Technical problems concerning manufacturing, storing and use of oxygen and fuel gases.

C.—Technical problems concerning equipment and fittings, cylinders, reducing valves, valves, cocks, etc.

D.—Standardization.—Transportation.—Regulations.

Acetylene

A.—Technical problems in connection with acetylene generating plants.

B.—Purification of acetylene.

C.—Acetylene installations.

D.—Dissolved acetylene.

E.—Acetylene lighting.—Stationary lighting.—Portable lighting.—Signal lamps, etc.

F.—Acetylene heating.

G.—Acetylene in connection with motive power.

H.—Sundry applications.—Regulations.—Standardization.

Welding

A.—Welding plants.—Blowpipes.—Equipment and accessories.

B.—Weldability of metals and alloys.—Filling metals and fluxes.

C.—Welding methods.—Execution of welds.—The welding of various metals.—Metallography.—Weld testing methods.

D.—The application of welding—construction and repair work.

E.—Metal cutting.

F.—Electric welding and cutting.

G.—Teaching and training.

H.—General regulations.—Health regulations.—Safety.

The provisional program of proceedings is as follows:

July 5, 1927

Morning.—9:30—Inaugural meeting of the Congress.—Organization of the sections.—Adjustment of the program proceedings.

Afternoon.—2:30—Meeting of the first section—Calcium carbide.

3:30—Meeting of the second section—Oxygen.

5:00—General meeting.

July 6, 1927

Morning.—9:00—Meeting of the third section—Acetylene.

10:30—Meeting of the fourth section—Autogenous welding.

Afternoon.—2:30—Meeting of the third section—Acetylene.

3:30—Meeting of the fourth section—Autogenous welding.

5:00—General meeting.

July 7, 1927

Morning.—9:00—Continuation of section work.

11:00—General meeting—Reports, resolutions, etc.

Afternoon.—2:30—General meeting—Discussion of reports.

Closing meeting.

8:00 P. M.—Banquet.

July 8, 1927

Inspection trip—Visit to the City of Ghent and the electric power station of Flanders.

The secretary general of the Congress, in a recent letter, has tendered the following invitation to the International Acetylene Association:

International Acetylene Association,
30 East 42nd Street,
New York, N. Y.

Gentlemen:

We have the honor to invite you to take part in the Ninth International Congress of Acetylene, Autogenous Welding and Allied Industries, which will take place in Brussels on the 5th, 6th, 7th and 8th of July, 1927, in accordance with the program attached.

We beg to request your kind and special assistance in sending out in your country to organizations, firms and individuals, whom you think would be interested, information about the Congress. We shall be glad to provide you with copies of the program, translated into your language.

Special circumstances make it necessary for us to ask you to reply to us as soon as possible.

We get you to excuse us for asking for your assistance, but thank you in advance for the consideration with which we are assured you will receive our proposition.

Very truly yours,

(Signed) Secretary General.

Structural Steel in Machine Design

The Substitution of Steel Shapes for Cast Iron Brings Economies in Manufacture Without Sacrificing any Service Qualities in the Finished Product

By E. E. Dreese*

(Note—This is the second of a series of articles on Redesign Engineering. The third will appear in an early issue.—Editor.)

ONE of the most prominent milestones marking modern progress is the improvement in the use of materials in Industry and Commerce. The first railway rails were made of wood with, later on, a strip of iron attached to the top. Even the wooden rail might have endured longer if there had been a satisfactory method of attaching the metal strip to it. It was quite common for this strip to come loose and curl up

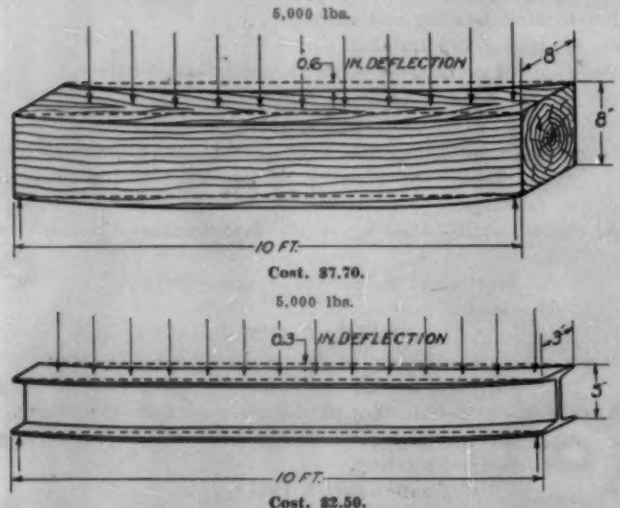


Fig 1.—Wooden Beam and Steel Beam of Equal Strength.

through the floor of the car like an iron snake to the consternation of the passengers and the exasperation of the operators. The present day steel rail is a far cry from its progenitor and represents years of experience and adaptation. There is still trouble with the fastenings, however. It is now in the connection between the steel rail and the wooden tie. Steel ties are coming in and with steel rails and steel ties the fastening question will probably subside.

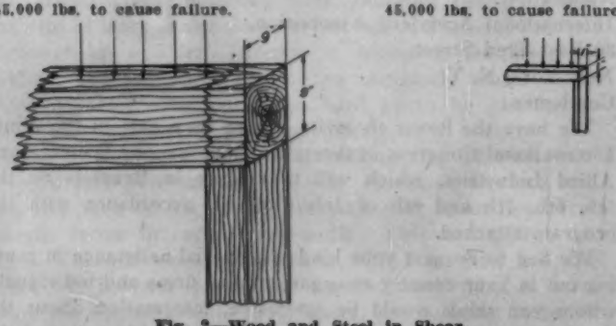


Fig. 2—Wood and Steel in Shear.

Wood in Shear—cost 8 cents per linear inch. Steel in Shear—cost 0.45 cents per linear inch.

Instead of the railway rail we might follow ship construction from the wooden hull wind-jammer era to the present day of steel and steam. What a narrative it would make to follow this progress from the romantic and storied past to the no less romantic present with its fleets of Leviathans, truly symphonies in steel. This evolution in the use of materials might be exemplified in a thousand ways. Numberless cases are always at hand which need only the application of an active imagination to grow into an absorbing story of progress in the use of materials with a multitude of ramifications down to the very roots of industry. If we consider such seemingly prosaic things as railway cars, both freight and passenger, metal "woodwork" window sills, pipe and pipe lines, bridges, trolley and light poles, fences, animal shelters, or any of countless others we get a glimpse of what we may call "Evolution in construction."

One phase of this evolution consists in utilizing the materials of fabrication in the places which properly belong to them because of cost and physical properties. Another phase has to do with methods of fastening the various materials together. It has happened that in many cases a material otherwise suited for a particular use could not be used because the method of fastening it into place was not satisfactory. A third consideration is the matter of shape and form. Many things

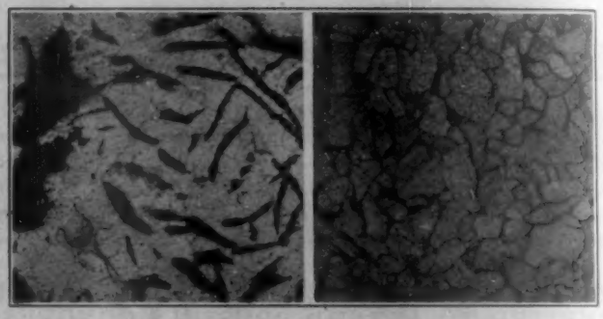


Fig. 3—Microphotographs of Cast Iron and Steel.

in use today have certain shapes for certain reasons. The reason may be utilitarian or it may be aesthetic, or it may be just custom.

The reason for the extensive replacement of wood by steel can easily be understood from a comparison of some of the physical properties of the two materials. The ultimate fibre stress for bending in wood is 5,000 lbs. per square inch and is 60,000 in steel—a 12 to 1 advantage in favor of steel. In other words an 8x8 inch white pine beam spanning 10 feet, will carry a uniform load of 5,000 lbs. The beam has a section of 64 square inches, deflects 0.6 inch at the center and costs about $7.70. A steel beam to carry the same load has a section of 2.87 square inches, deflects 0.3 inch and costs $2.50. The deflection of the wooden beam is too great to carry a plastered ceiling while the deflection of the steel beam is satisfactory for that purpose.

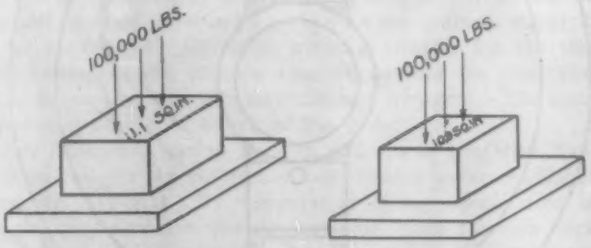
In shear, wood has an ultimate fibre stress of 550 lbs. per square inch, while steel has an ultimate of 45,000 lbs. per square inch and thus in shear, steel is 82 times as strong as wood. If we consider now a shearing load and have arrived at the point where a selection of material to take this load is to be made we are faced with the following situation. Say a section of 82 square inches of wood is required to carry this

*Chief Engineer, Lincoln Electric Company, Cleveland.

shearing load. This section of wood will cost about 8 cents per linear inch. This 82 square inch wood section can be replaced by 1 square inch of steel and obtain the same strength. This section of steel costs about 0.45 cents per linear inch. This is an 18 to 1 advantage in cost in favor of steel in shear. In industry and commerce where strength and cost are ever present considerations such economies in space and cost will assert themselves with overpowering force. The evolution in the use of material is proof of this.

The replacement of wood by steel is not the only place, however, where changes in material are taking place. Recently another movement has started which will rival the foregoing if not surpass it. This is the displacement of cast iron by steel. Steel is displacing cast iron for the same reason that it has displaced wood to a growing extent—the physical properties of steel are such that it is better adapted to construction and manufacture than is cast iron.

The two microphotographs shown in Fig. 3 show the essential difference between cast iron and steel as far as structure is concerned. Both steel and cast iron contain carbon. The essential difference is that in the case of cast iron the carbon is collected together or segregated into curved plate-like shapes distributed through the mass of the piece while in steel the carbon is chemically combined with the iron and improves its strength. This segregation of carbon in cast iron is clearly shown in the photograph (magnified 100 times). These carbon plates are weak and break up the continuity of the metallic structure. As far as the strength of the cast iron is concerned, these carbon plates might just as well be holes in the material. In the steel shown the carbon in chemical combination with the iron is found in the boundaries of the crystals. Now, this



Cast Iron
Cost—34 cents.
Compression—1.6 thousandths in.

Steel
Cost—15 cents.
Compression—.6 thousandths in.

Fig. 4—Cast Iron and Steel in Compression.

boundary material, unlike the carbon plates in cast iron, is so strong that when a rupture starts in steel this boundary material is intact long after the crystals themselves have ruptured. This carbon-iron mixture forms a cement tougher than the aggregate or crystals of pure iron.

The question logically arises then—why is cast iron used at all if steel is a better material. Let us examine the reasons as we enumerate them.

In the first place, the tables of strength of materials show that cast iron has a compressive strength of 90,000 lbs. per square inch and that steel has about 55,000 lbs. per square inch. This would seem to show that cast iron is stronger than steel *in compression*. This seeming truth is one of the reasons for the use of cast iron, but let us examine it more closely and compare the *working* stresses. Now, the strength as given in the tables is the ultimate stress which causes failure. Of course, we do not intend to use our material at the breaking point. We wish to use it at the working point or as engineers say at the "working stress." Now this working stress is arrived at by dividing the ultimate strength by a number called the "Factor of Safety." Sound engineering practice stipulates the following safety factors for cast iron and structural steel:*

*See Elements of Machine Design by Lentwiler.

Safety Factors

Material	Kind of Load Steady	Varying	Shock
Cast Iron	6	10	20
Structural Steel	4	6	10

Now let us divide the compressive strengths by the various factors of safety and set the results down in tabular form as working stresses.

Compressive Working Stresses in Lbs. Per Square Inch

Material	Kind of Load Steady	Varying	Shock
Cast Iron	15,000	9,000	4,500
Structural Steel	13,750	9,160	5,500

Thus when we get to the working stresses the supposed superiority of cast iron over steel has disappeared in those

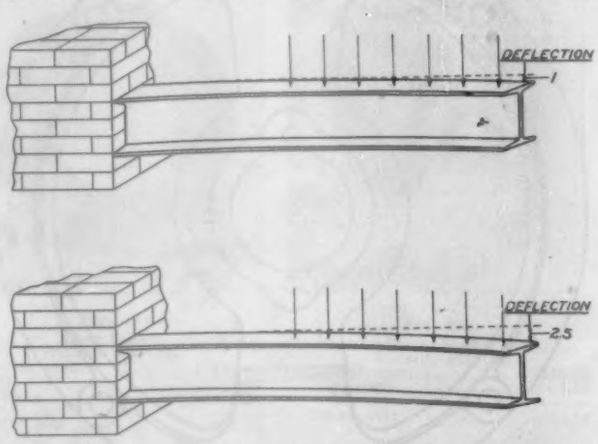


Fig. 5—Steel and Cast Iron Beams of Identical Dimensions.

Steel	Equal Section	Cast Iron
Sag—1 inch.		Sag—2.5 inches.
Cost—2.5 cents.		Cost—6 cents.

cases where the load is not steady which includes most applications in machine design.

Now let us consider the relative costs of the two materials as compression members—let us choose the case of a varying load, because steady loads seldom occur in machine practice. Suppose we wish a block to take 100,000 lbs. of compression and to be 2 inches thick. The cast iron block will have an area of 100,000 or 11.1 square inches.

9,000

It will cost 34 cents at 6 cents per lb. A steel block to take the same load will have an area practically the same. It will

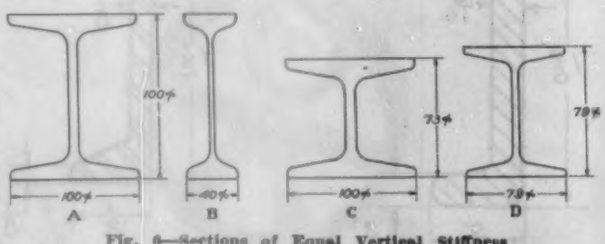


Fig. 6—Sections of Equal Vertical Stiffness

	Cast Iron Percent	Steel Skrunken Width Percent	Steel Shrunken Height Percent	Steel Shrunken Width and Height Percent
Stiffness	100	100	100	100
Weight	100	40	73	79
Working Strength	100	240	320	296
Cost	100	16	30	26

cost 15 cents at .025 cents per lb. but this is not all. The cast iron block of slightly greater section and greater weight will "give" over twice as much as the steel block.

Thus we save by using steel for compression 56 per cent of the material cost with less than half the deflection at approximately the same weight and volume.

A second supposed advantage of cast iron over steel is that

cast iron is thought to be stiffer than steel. To an engineer the moduli of elasticity tell the story. The moduli are numbers which show the relative stiffness of materials. The modulus for steel is 30,000,000 and for cast iron is only 12,000,000 or steel is two and one-half times as stiff as cast iron. Translated into non-technical language this means that if a steel beam carrying a load and sagging a certain amount were changed to cast iron of the same dimensions, the sag of the cast iron beam would be two and one-half times as great. That is, it would sag two and one-half times as much provided it didn't break because of its lesser strength.

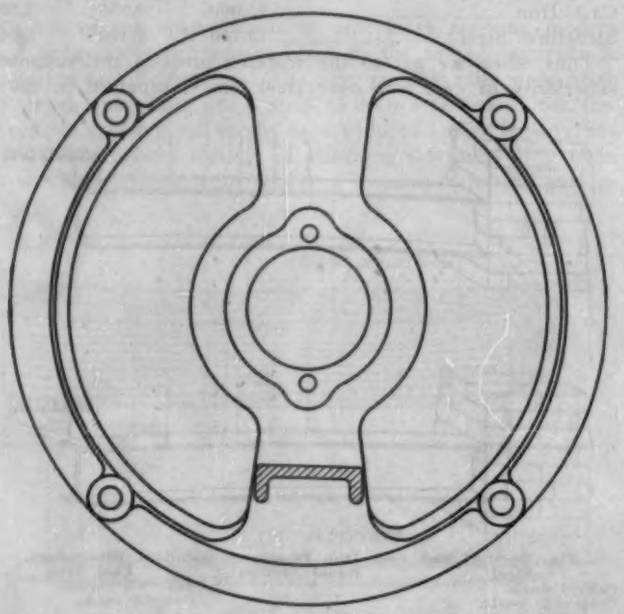


Fig. 7—The Cross Section of the Cast Iron Arm and of the Standard Steel Channel Which Replaced It are Shown Below

Therefore, if we should replace a cast iron section in bending by an equal section of steel, we would find that the sag or deflection would be reduced by 60 per cent and the cost by 60 per cent also.

Ordinarily, however, the designer would wish to take advantage of the superior strength and stiffness of the steel and

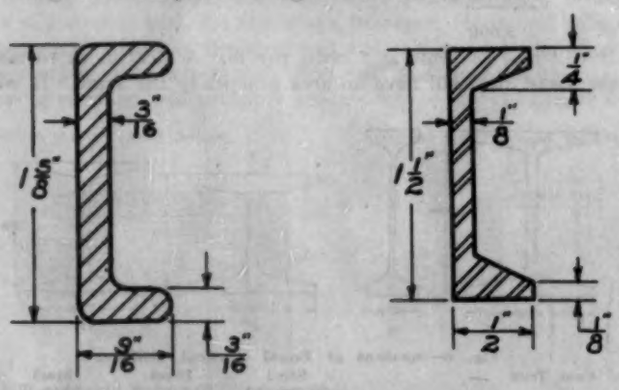


Fig. 8.

Cast Iron Arm	Steel Arm
Weight—100%	Weight—74%
Stiffness—100%	Stiffness—154%
Ultimate Strength—100%	Ultimate Strength—109%
Working Strength—100%	Working Strength—180%
Cost—100%	Cost—30%

thereby effect even greater reduction in the cost than the 60 per cent given above.

Tensile Strengths

	Cast Iron	Steel
Ultimate Strength	15,000	55,000
Factors of Safety	10	6
Working Stress	1,500	9,200
Modulus of Elasticity	12,000,000	30,000,000

Analysis of these figures shows that in tension the allowable working stress of steel is about 6 times the allowable working stress for cast iron. This means that where *strength in tension* is the *only* consideration, the section of cast iron may be replaced by 16.6 per cent of that section in steel. Now, if cast iron costs 6 cents per lb. and steel costs 2.5 cents per lb. or 42 per cent of the cast iron cost, the relative cost of steel and cast iron for equal working strength in tension is

.42 × 16.6 or 7% of cast iron cost.

Great care must be exercised at this point because, while steel is 6 times as strong as cast iron in tension, it is just 2.5 times as stiff. This mean that we must know in the replacement of cast iron in tension, whether we wish the steel to be as *strong* as cast iron or as *stiff* as cast iron. Mistakes in this replacement have been made in the past which undoubtedly gave rise to the erroneous idea that cast iron was stiffer than steel. It is quite obvious that if a section in tension is cut down to 16.6 per cent when steel is substituted, that the 16.6 per cent steel will not be as stiff as the 100 per cent of cast iron, but instead 40 per cent of steel will be as stiff as 100 per cent cast iron.

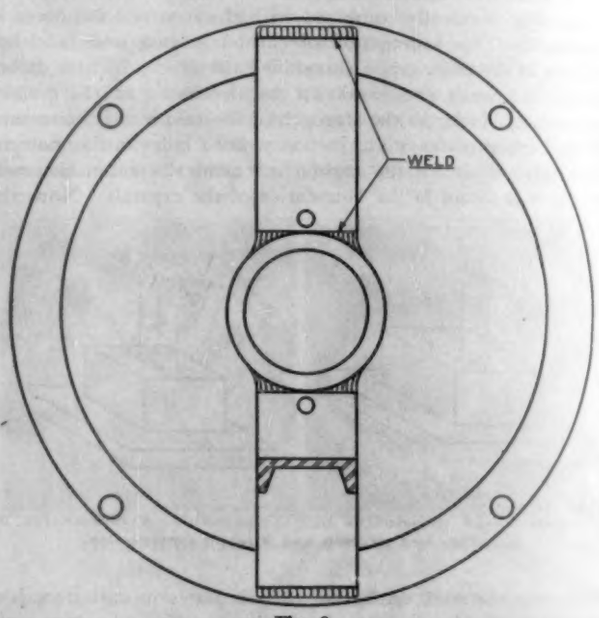


Fig. 9.

In the replacement of cast iron by steel in a part subjected to bending we must take account of not only the relative *areas* of the sections of cast iron and steel but we must also take account of the *shapes* of the selections. It is common knowledge that a board is stronger and stiffer if bent edgewise than if bent flatwise. Strength and stiffness in bending are obtained by keeping the material of the section as far from the center as possible. The I-beams and channels are ideal illustrations of this principle because their great strength and stiffness are due to the material in the flanges located at a distance from the center of the section. In changing from cast iron to steel in bending the effect of shape of section must, of course, be taken into consideration. The illustrations in Fig. 6 show various ways of replacing a cast iron part by steel. Here the effects of changing the vertical and horizontal dimensions separately may be seen. In order to be able to draw general conclusions as set down below the separate sketches, it was assumed that when the horizontal dimensions (for instance) were changed that *all* horizontal dimensions were shrunk in the same proportion—this includes clearances and thickness of material in that particular direction. The same assumption was made in the other case.

The important conclusion to be drawn from this figure is that since steel is 2.5 times as stiff as cast iron it does not follow necessarily that we can divide the weight of cast iron by 2.5 to get the weight of steel. This can be done only in case the dimensions in the direction of bending are substantially unchanged or increased. In many cases, too, the most available steel section will give a different strength or stiffness than we get in the ideal cases considered in Fig. 7.

An example of this has recently occurred in the replacement of cast iron by steel in a motor end bracket. The cast iron bracket is shown in Fig. 7. The arms of this bracket are subjected to bending and compared on the basis of the ideal sections in Fig. 6. The results are shown in Fig. 8.

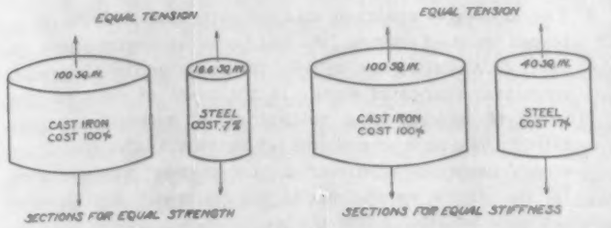


Fig. 10.

For equal working strength in tension replace cast iron section by 16.6% of that section in steel.

For equal stiffness or deflection in tension replace cast iron by 40% of that section in steel.

In this case, then, we have made a substitution of material which saves us not only 60 per cent in cost pound for pound but we have actually been able to use 26 per cent less pounds of the cheaper material. This means that for 30 per cent of the cost of the cast iron arm we get a steel arm which has 54 per cent more stiffness and 9 per cent more ultimate strength. If we consider the allowable working stresses for the two arms instead of the ultimate stresses we find the steel arm to be 80 per cent stronger than the cast iron arm. The completed steel bracket is shown in Fig. 9.

This illustration had to do with stiffness in bending. Suppose we consider the stiffness in compression under conditions as shown in Fig. 4. By computation of the compression of the two pieces we see that the cast iron block 2 inches thick is compressed 1.5 thousandths of an inch, while the steel block is compressed only .6 thousandths. When it is seen that the deflection of cast iron is more than twice that of steel with the steel working at the same stress and costing less than half as much as cast iron, we can see that on the question of stiffness cast iron is hopelessly outclassed.

In this connection we should inquire into the relative properties of cast iron and steel in tension. Steel has an ultimate strength of 55,000 lbs. per square inch in tension while cast iron is good only for 15,000 lbs. per square inch. These are ultimate or rupturing stresses. To arrive at the working stresses we should apply the factors of safety as we did in the illustration of compression stresses.

Casting seems to enjoy a preference as a method of construction where the parts are of involved and of intricate shape. The greatest economies are realized if we can replace cast iron by standard structural steel which costs about 2.5 cents per pound. The question arises as to the methods of replacing the odd and intricate shapes of casting by the more or less standardized shapes of structural steel. The "open sesame" is the electric weld and certain simple tools and fixtures to convert the standard structural shapes into other forms. If a casting is studied it will usually be found to consist of parts that are very little different from standard structural shapes. In many other cases where there is nothing in the casting that suggests a steel shape, steel may be substituted by modifying the general shape or appearance of the part.

This study and analysis of casting shapes yields to the same treatment that any other problem yields to. If any problem is broken into its parts, and the parts studied and valued the problem will be solved. Absence of this mental process is the greatest single handicap in realizing the economies of steel construction over cast iron. It is a fundamental fact that the elementary parts of a casting of whatever shape are little, if any, different from the standard structural shapes.

Consider, as an example, the motor frame shown in the illustration, Fig. 11a. At first glance, perhaps, there is nothing in the casting that suggests a structural shape. Analysis

Fig. 11a.
Cast Frame
Weight, 539 lbs.

Material cost	$23.60
Labor cost	1.37
Breakage	.35
Total cost	$25.32

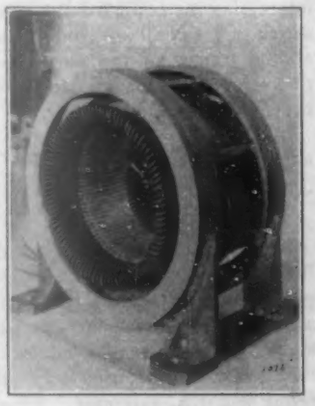


Fig. 11b.
Steel Frame
Weight, 370 lbs.

Material cost	$10.90
Labor cost	3.20
Total cost	$14.10

of the casting shape discloses that it consists essentially of two rings joined together by cross ties and supported by feet cast integral with the frame.

Now, examine the steel frame that replaces it in Fig. 11b. Here we see the elements of the frame more clearly. The rings are formed of ordinary structural angle rolled to form a ring and the gap welded. The cross ties are simply pieces of steel flat stock cut to length and welded into the frame rings. The feet are also fashioned from flat stock. The radius of the foot where it fits on the frame ring is punched. The actual costs excluding the lamination which is the same in each case and not a part of the casting are shown below the illustrations.

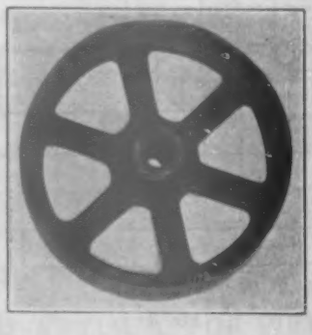


Figure 12.

Cast Iron Weight, 25 lbs.		Steel Weight, 12.5 lbs.	
Cost of material	$1.84	Cost of material	$0.37
		Labor	.41
		Total	$0.78

The saving is $11.72 or 45 per cent in cost and 219 lbs. or 37 per cent in weight.

In the case of the steel frame the labor cost, $3.20, includes all the operations of cutting the material, rolling the rings, and welding the whole together as shown in the illustration. The reduction in weight of 37 per cent of the weight of the

frame is also a saving of 10 per cent of the total weight of the motor and affects freight charges exactly as much as a 10 per cent reduction in freight rates.

The item of breakage is one that is sometimes not considered. In a factory where this breakage item is below normal over a period of time $35,000 worth of castings were used. Of this amount there was a loss of $944 worth of castings broken during processing, carrying with it a loss of $300 in lost labor. The total loss of $1,244 amounts to 3.5 per cent of the value of the castings.

On this particular replacement of cast iron by steel, it is interesting to compare the initial costs necessary to put this series of frames into production. "Series" as here used means all the frames of the same diameter but various lengths. In the present case there are five frames in the series. These costs are tabulated below.

Cast Iron		Steel	
Patterns	$1,400	Rolling Fixture	$200
		Cut off Dies	125
Total	$1,400	Welding Jigs	70
		Total	$395

As another example of welded steel construction consider the cast iron truck wheel, shown in Fig. 12. It seems a simple problem to replace this cast iron wheel by steel. As it is, a natural solution would seem to be to wind up a piece of flat stock in the form of a circle and weld spokes from this rim to a piece of pipe used at a hub. But there is an additional requirement in this case. This requirement is that the wheel

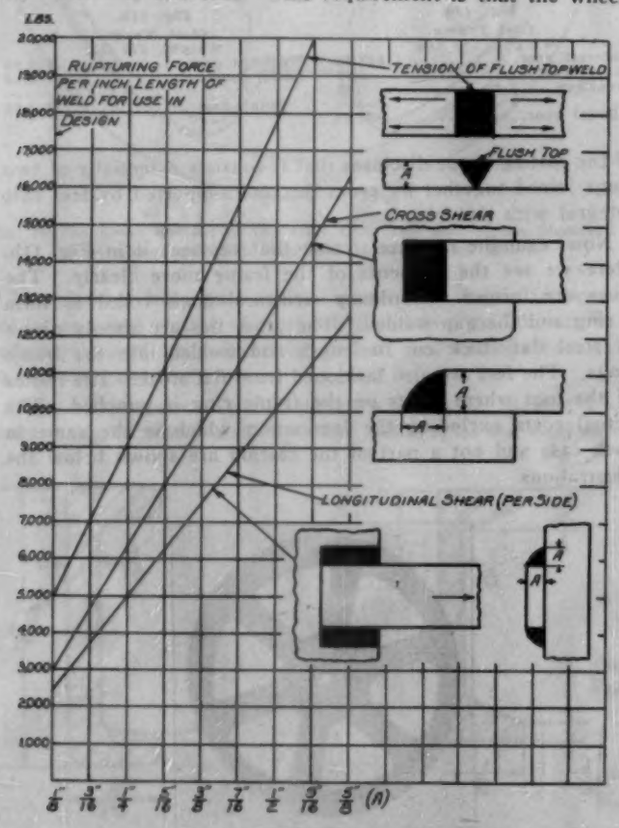


Fig. 12.

must be very stiff in the rim and not develop flat spots between the spokes. This requirement was met by rolling up a standard T bar for the rim and welding the spokes to the web of this T bar. The hub is made of a length of steel pipe.

Instead of the examples cited, any one of a myriad might have been used. A brief list of examples where welded steel is displacing cast iron is:

Machine Bases and Platforms.
Motor and Generator Frames and End Brackets.
Base Rails.
Bearing Pedestals.
Jigs and Fixtures.
Fans and Blowers.
Wheels.
Machinery Frames.
Ship Fittings.
Link Mechanisms.

The design process by which these savings are made is somewhat as follows:

1. A study is made of the casting and it is definitely decided just what the casting does in the machine and the requirements it must meet. Once this is done, it is simple to decide whether or not a suggested change in form or shape in changing to steel is allowable.
2. The casting is analyzed into its parts and these parts replaced by steel shapes. As has been previously stated the parts of a casting are usually the same as the elementary structural shapes in steel. If the point of view is cultivated of looking at a casting as an assembly of parts rather than as a composite whole this analysis of shape comes naturally whenever a new casting presents itself. It is a simple psychological process which any designer can pick up after a few trials.
3. It sometimes occurs that all parts of a particular casting can be replaced by standard structural steel, except some detail which is necessarily of peculiar shape. In this event, the rolling or bending fixture will take care of 90% of these cases by changing the form of a standard steel shape to make it conform to the necessities of the design. The rolling of the straight angle steel into a circular ring as shown in Fig. 11b is an example of this process.
4. There may still occur some details which do not seem susceptible to the rolling or bending processes. In such cases (which are very rare) recourse must be made to a cast or a pressed steel part. If in an extreme case and one which seldom occurs 90% of a cast iron part can be changed to structural steel and 10% to cast steel, there is still a saving which is very much worth while.

Electric arc welding is the master key to the domain of steel construction. The questions naturally arise—what is welding, what does it cost, and how strong are the welds. We shall now proceed to answer these questions one by one.

What is welding? Welding is a process of joining metals by heating the junction until the pieces are in a plastic or fluid state and then obtaining a union.

In arc welding, an electric arc is the source of heat. When an electric circuit is broken an arc always results. This arc is due to incandescent vapor forming at the break. This vapor acting as a conductor completes the circuit and has a high resistance especially at the junction of the vapor and the terminals (called electrodes). The resistance results in considerable heat being released in a very small space. In arc welding this arc is arranged to come at the point where the weld is to be made. The heat of the arc melts the pieces at the junction and a weld results. As stated above in the electric arc the heat is liberated at the *terminals* of the arc. When the arc is applied to welding this results in a great economy of heating since the heat is developed *in* the work and the heating is extremely localized. There are two principal kinds of arc welding electrodes, carbon and metallic. The difference is that in one case the arc occurs between the work and a carbon rod and in the other case between the work and a metallic rod. In carbon arc welding a filler rod is necessary if metal is to be added to the weld while in the case of metallic arc work the added material is supplied by the melting of the metallic terminal.

Of the two the carbon arc method is essentially a puddling process. The molten metal is formed in a pool and is kept molten by playing the arc across its surface until the necessary filling has been completed. Owing to this fact, it is not

as applicable to vertical and overhead welding as is the metallic arc process.

The metallic arc process is not a puddling process but is a *deposition* process. As pointed out above, the heat of an electric arc occurs principally at the two electrodes or ends of the arc. In the case of the metallic arc, one end being the work is heated until it melts which action is practically instantaneous. At the same time, the tip of the metallic welding rod—that is, the other electrode—is melted and a globule of molten metal forms. This globule is then carried across the arc and deposited in the molten seat waiting for it in the work. The word "carried" is correct rather than "dropped," because gravity does nothing but assist this deposition of metal when the work is flat. The fact that this globule of molten steel will be deposited *overhead* and against the force of gravity is proof that the process is one of deposition. Upon this fact depends the utility of the metallic arc in overhead welding.

Arc welding has developed a science and technique of its own into a discussion of which it is not our purpose to enter except in passing. Fundamental principles of arc welding are being actively sought in the physics, chemistry and metallurgy of the process. Besides demanding welds of a superior grade—operators and management alike demand speed. Speed and ease of operation as well as quality of weld all demand stability of the arc. Stability is that quality of an arc that describes its steadiness and tractability. Lack of stability causes an arc to be "wild." In this condition the arc sputters about and jumps from place to place on the work. A great deal of metal is spattered around in globules and the arc is often interrupted and needs to be remade. This results in loss of production and frays the nerves of the operators. The matter of arc stability is largely determined by the characteristics of the machine supplying the current to the arc.

The question sometimes arises as to the advisability of the use of rivets in replacing cast iron by steel. Riveted construction costs more and is less effective than the welded joint.

Rivets work loose if subjected to repeated severe strains while in a weld the parts are knit together into one whole. Moreover no riveted joint can have 100% strength but usually runs from 60% to 85% while welded joints may have strength efficiencies of 100% or over. Ofttimes because of the low efficiency of riveted joints the members connected have to be extravagantly designed in order to stand the reduction in strength at the joint. None of this is necessary with welded joints.

When the designer considers welding one of his first questions is—how strong are welds. The latest figures on the strength of welds are gotten from the results of extensive tests carried out by the Morgan Engineering Company of Alliance, Ohio, together with the Lincoln Electric Company of Cleveland, Ohio. They have recently erected a steel building using welded construction instead of rivets.

The tests were conducted primarily to determine the amount of weld necessary to replace a rivet. Having such a figure they then converted riveted design to welded design. The writer has taken the results of the Morgan Engineering Company experiments and analyzed them in a different way for the purpose of this article. In figure 13 is shown the *rupturing* force per linear inch for various welds. The values given are the minimum force required in each case and are for use in design work. Generally the rupturing force will be above the values given. Fully 90% of the welding in the replacement of cast iron by steel will be welds for shearing strength. But butt-welds do occur and so the tension figures are included to cover this case. The butt or tension weld may be reinforced by building up the weld higher than the surface of the adjoining parent metal. In that case the strength may be estimated by taking the dimension "A" on the curves for the thickness of the weld and not for the thickness of the plate as in the flush-top illustration. These experiments when combined with others show that there is a difference in strength if the weld is sheared transversely and when sheared longitudinally. This is shown in Figure 13.

This superiority of cross shearing to longitudinal shearing shows that the welding economy will be greatest if we take every possible chance of laying down cross shear welds and then lay down enough longitudinal shear weld to get the required strength or stiffness. As an example suppose the flat piece "A" in the illustration of Figure 14 is to be welded to piece "B" as shown.

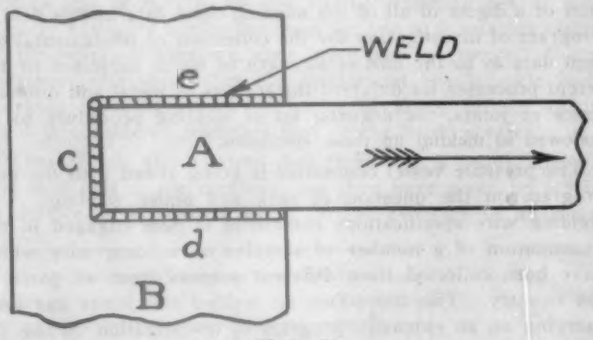


Figure 14.
Weld Metal Laid Along the Edge "C" is About 30% Stronger Than the Same Metal Laid Along Edges "E" or "D."

It will often occur on production work that the welding is a perfectly standard operation, always done in the same way and along simple lines. At this point, the automatic arc-welder comes into its own. In automatic arc welding, the relative motion of the arc and the work is regulated by machinery instead of by hand. The speed is considerably greater than hand work, but the process is more limited to a standardized operation. The automatic arc-welder is to arc welding what the sewing machine is to sewing. When the seams are long enough and are not of intricate form, the seamstress uses the sewing machine and lays her needle and thread away. She may use the needle and thread to hold the pieces in place while the sewing machine does its operation. So it is in automatic welding. The operator lays his hand electrode aside, but may use it to tack-weld the pieces to be welded in position while the automatic makes the finished job.

Such is in brief outline the process by which industry, as inexorably as nature, is eliminating the unfit for the more fit. If history ever designates a cast iron age it will be the period we are just now leaving. The age of steel is here.

SUMMER COURSE AT CARNEGIE

With the exception of a few guest instructors and special lecturers, none but members of the regular college teaching staff have been appointed to the faculty for the summer courses this year at the Carnegie Institute of Technology, according to an announcement from the Pittsburgh institution. The guest members of the faculty, it is further announced, will be on duty at various periods during the six weeks courses for teachers from June 27 to August 5 in the College of Fine Arts. For the eight weeks courses from June 13 to August 5 for undergraduates in the industrial and engineering courses, only members of the regular college faculty have been engaged.

NOVEL ADVERTISING FOR WELDING SHOP

An unusual medium of advertising has been adopted by the Broadway Metal Weld Company of Denver, Colorado, who have broadcasted their selling story from a local radio station once a week for six weeks. Since they wanted particularly to reach the housewives and the farmers within a radius of 100 miles from Denver, they used a small station and broadcasted their program between 7 and 8 P. M. Although it has been difficult to trace the results, they do know of one big job, obtained through the radio programs, which paid the cost of the entire schedule.

RESEARCH EMPHASIZED AT ANNUAL MEETING OF AMERICAN WELDING SOCIETY

The two main general topics emphasized in the papers and discussions at the annual spring meeting of the American Welding Society, held in New York April 27th to 29th, were the usefulness of research work to the welding industry and the applications of welding to production work.

The activities of the structural steel welding committee, of which M. J. H. Edwards, assistant chief engineer of the American Bridge Company is chairman, covered the compilation of a digest of all of the existing tests data in this field, a program of investigation for the collection of fundamental design data as to the unit of strength of welds subjected to different processes for different thicknesses of metal and different types of joints, the drawing up of welding procedure to be followed in making up these specimens.

The pressure vessel committee is going ahead with the new program on the question of tank and boiler welding. The welding wire specifications committee is now engaged in the examination of a number of samples of welding wire which have been collected from different sources from all parts of the country. The committee on welded rail joints has been carrying on an extensive program of investigation during the past two years, with the object of finding a way to improve the seam welded type of joint.

In the field of production welding an interesting application was introduced by Mr. J. A. Deppler, of the Metal & Thermit Corporation, Jersey City, N. J. Some of the better known types of production welds accomplished by the Thermit Corporation are rail joints and pipe. Lately, however, experiments have been made with Thermit welding seams three feet long in tanks of 24 inches in diameter, made of two-inch thick material. The speaker said that experiments have already been carried far enough to indicate that such welds could be received without danger and that a heavy tank so constructed could be distorted at will. He also pointed out that the research work of the company has made it possible to accomplish vast improvement in the application of Thermit welding to repair work. A development in the resistance welding field, which led to considerable saving was described by H. W. Tobey of the General Electric Company, Fittsfield, Mass., who read a paper on resistance line welding. In the case he described many lengths of sheet were welded togther by resistance line welding machine so that they formed one long continuous ribbon. This ribbon was fed into a punch press for the production of sheet steel punchings used in transformer cores, and reduced the waste of sheet steel from 35 per cent to 10 per cent.

Mr. J. F. Lincoln, vice-president of the Lincoln Electric Company, Cleveland, touched upon a field of application for arc welding, which so far has been cultivated to a very limited extent, but which has great possibilities for the future, that is, the substitution of welded steel shapes for iron castings in the production of machinery bases, etc. The advantages of steel over cast iron were explained in detail and the necessity for complete change of design of the structure in most cases was emphasized.

Mr. C. J. Holslag of the Electric Arc Cutting & Welding Company, Newark, N. J., described the construction of a welded house having a steel frame instead of a wood frame. It was pointed out in this paper that there is an enormous amount of work possible for welding in the domain of small steel structures.

Mr. M. F. Bayer, of the Simmons Company, Kenosha, Wis., described the production of metal furniture at their plant, using the oxy-acetylene process. In the welding of tin steel tubes and channels, a special bronze filler rod is used, and the process proves to be admirably adapted to the production of high-grade steel furniture.

Mr. F. E. Kline outlined the use of oxy-acetylene welding in the manufacture of aluminum automobile bodies in the Pierce-Arrow plant. He placed special emphasis on the importance of using a high-grade flux.

The production welding of aluminum by the resistance process has often proved unsatisfactory on account of the tendency of the aluminum to stick to the copper electrode. Considerable progress has been made in the development of electrode tipped with Elkonite metal, which does not have this tendency to alloy with the aluminum.

Another interesting feature of production work described at the meeting was the fabrication of railroad ties from worn and discarded rails. In one shop, 15,000 ties is the estimated annual production from an automatic welding and clamping machine which has been developed for this purpose.

Reports received from manufacturers in the course of the program indicated that considerable progress has been made in the development of welding equipment during the past year, as the result of research work in commercial laboratories. The research work of some of the larger users of welding, produced some equally interesting papers. Mr. R. R. Moore described in considerable detail a series of tests run at McCook Field. The material tested, consisted of one-half and one-inch cold drawn seamless tubes of 1025 steel and also a test of metal deposited with Norway iron and also with the coated steel welding wire. The apparatus used for testing was a rotating beam type of fatigue testing machine, which subjects the specimen to flexural stresses, passing through a complete cycle from tension to compression equal in magnitude. The tests showed that fatigue tests are especially good for discovering poor fusion, a condition which may not be so easily detected by the tension test. It was also concluded that long time fatigue tests show that the deposited metal has a definite endurance limit just as found in steel. J. W. Owen, director of welding of the Newport News Ship Building & Dry Dock Company, described a series of tests which are typical of the problems encountered by his department. A test to determine the technique of spot welding galvanized iron number 24 to number 11 USS gauge indicated that the requirement for successful welds, were well rounded die points, twice the current and half the pressure required for black metal. He stated that the zinc appearing at the electrode point should not be removed and the points should be kept in shape by frequent filing. Another test was to determine the best technique for flash welding of tungsten steel tips to medium carbon steel shanks in the manufacture of lathe and planer tools. His conclusion was that the cost of manufacturing cutting tools was approximately one-third the cost of tools made of solid tungsten steel. A test to determine the strength of Tobin and manganese bronze welds in cast iron indicated that in all cases they are higher than the parent metal.

Mr. J. J. Crowe, engineer in charge of research and development department of the Air Reduction Sales Company, described the research activities of that company as carried on in two laboratories.

R. B. Fehr of the Una Welding & Bonding Company, Cleveland, presented a comprehensive outline of the research work being conducted by that company in the development of welding machinery and welding rods, rail bonds and bonding processes and of the design and application of seam welded rail joints. The company has also conducted some interesting tests in the arc welding of structural steel. A further program of investigation of the possibility of arc welded structural steel fabrication was presented by A. M. Candy of the Westinghouse Electric & Mfg. Company, who have made great strides in this field by welding a five-story factory building.

Announcement was made of the election of the following officers for the Society for the coming year:

F. M. Farmer, president; J. H. Edwards, vice-president; R. L. Shepherd, G. O. Wilson, divisional vice-presidents; J. J. Crowe, W. H. Gibbs, H. S. Smith, W. C. Swift, directors.

Pressure Vessel Welding

Method of Welding a 43′ x 5′ Tank and Tests Which Show Dependability of Oxy-Acetylene Welding for this Construction

A remarkable contribution to the progress of oxy-acetylene welding is found in the design, construction and testing of pressure vessels by the Union Carbide Corporation and its subsidiaries. A test to destruction of a 40 ft. by 5 ft. tank was described last June at a joint meeting of the A. S. M. E. and the A. W. S., by S. W. Miller, of Union Carbide and Carbon Research Laboratories. At a subsequent meeting, held in January of this year, a series of papers by Mr. Miller, and Messrs. H. E. Rockefeller and T. W. Greene, Linde Air Products Co., and A. B. Kinzel, Union Carbide and Carbon Research Laboratories, gave the complete story of the welding procedure, the examination of the ruptured head, the determination of the stresses and the development of the head design. The following abstract tells the story of the test to destruction of one tank, gives a summary of the conclusions drawn from investigation of the failed head, and describes the procedure followed in the laying out and welding of the tank.

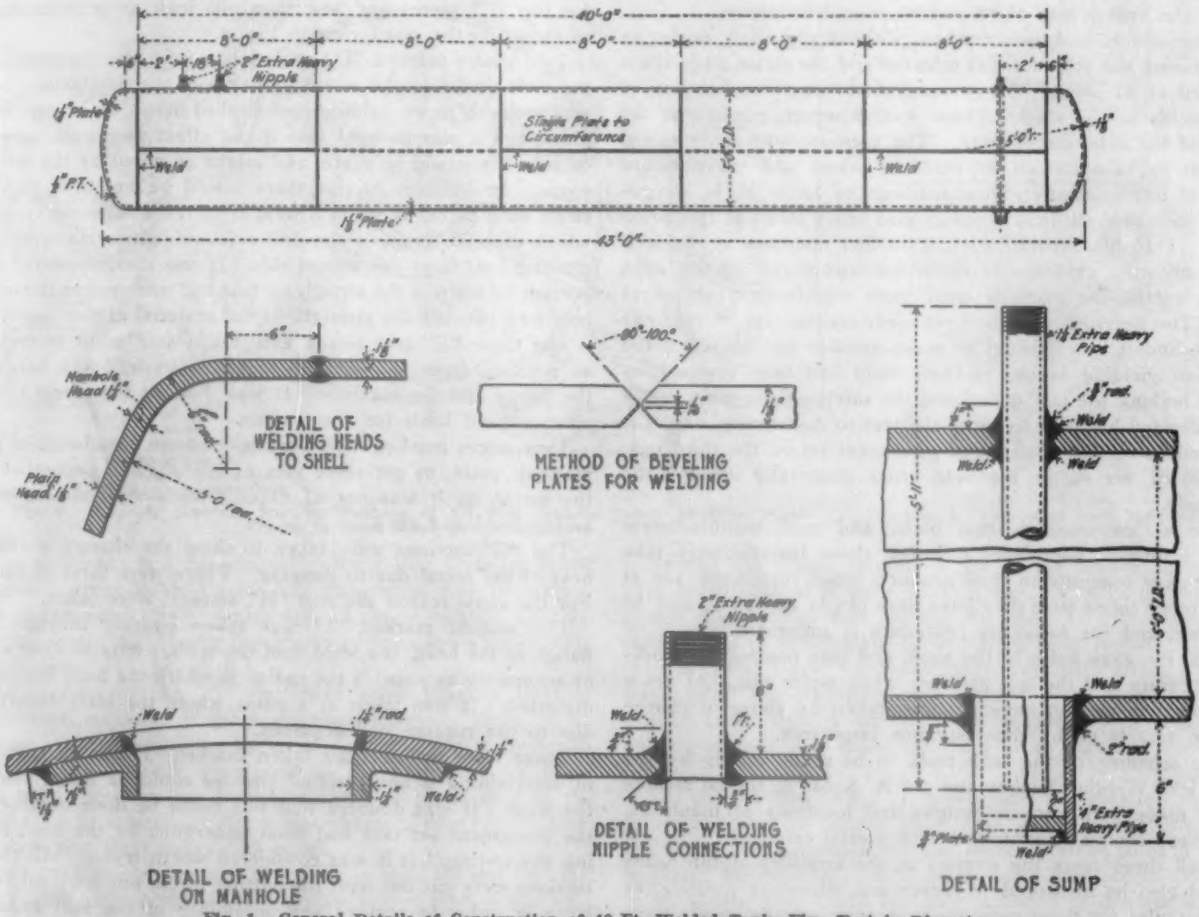


Fig. 1. General Details of Construction of 43-Ft. Welded Tank, Five Feet in Diameter.

For a number of years the Union Carbide Corporation has been having made in commercial shops pressure vessels for some of its subsidiaries, using oxyacetylene welding for making the joints.

The first large ones were 7 ft. in diameter, of ¾-in. plate in the shell, the heads being 1 in. thick on the closed end and 1⅛ in. on the manhole end. They were designed for 7,000 lb. working fiber stress in the shell and 5,600 lb. in the manhole head.

Under test these heads showed heavy stress at the knuckle, but as this seemed to be due to the rounding out of some slightly flat spots left by the flanging, and as it was not serious at the working pressure, they were put in service. Recent measurements show that the stresses at the knuckle under working pressure are of the order of 11,000 lb. per sq. in., so it is considered that this part of the head is safe.

These heads also showed that there was a heavy stress at the long axis of the manhole, but they have given no trouble in service, and as there is no further evidence of distortion, even though the strain gage shows the stress to be larger than desirable, it is considered that the heads are safe, although the stresses are checked at regular intervals.

In designing the latest series of tanks a higher working fiber stress was used, 8,000 lb. in the shell and 9,000 in the heads. These tanks were 5 ft. in diameter, for 300 lb. working pressure, and the shell was 1⅛ in. thick, the solid head 1⅛ in., and the manhole head 1¼ in. The general design of the tank is shown in Fig. 1.

The manhole head was made of flange steel of the following properties according to the mill test:

Ultimate strength, lb. per sq. in.	57,440
Elastic limit, lb. per sq. in.	36,500
Elongation, per cent in 8 in.	30.25

Carbon, per cent	0.18
Manganese, per cent	0.42
Phosphorous, per cent	0.011
Sulphur, per cent	0.030

It was the intention to test the tank according to the Pressure Vessel Code on the basis of 9,000 lb. working fiber stress, to see if this figure could be safely used in later designs. This corresponds to a working pressure of 337 lb. per sq. in. and a maximum test fiber stress of 27,000 lb. per sq. in.

The test was carried out in accordance with this program, strain-gage measurements being taken at all important points, this being the corporation's standard practice in the case of new designs.

The tank was first tested up to 900 lb., and it was found that the only permanent distortions that occurred were in the heads. On the solid head the only evidence of distortion was the formation of Luders' lines on the knuckle. On the head containing the manhole, however, even at 300 lb., the metal at the inside edge of the manhole stretched beyond the yield point, the apparent stress being about 46,500 lb. per sq. in. At 2 in. from the hole it was 23,200, which is still excessive.

After 900 lb. had been reached, without any effect except as mentioned, the pressure was released and the strain gage again applied at all points. No permanent set was found in any of the welds in the shell. There was, however, permanent set around the manhole opening. The pressure was again raised to 900 lb., another set of readings taken, and the pressure further increased after these readings to 1,015 lb., in accordance with the schedule, readings also being taken at this pressure. On this second test no further increase of Luders' lines or other evidence of distortion was found on the solid head, but on the manhole head there was further permanent set. The pressure was then released, another set of readings taken, and it was decided to make another test to see if the limit of yielding in the manhole head had been reached, as those making the test questioned the safety of the tank, and it was decided by them to carry the test to destruction unless it showed no further evidence of permanent set on the third test. At 930 lb. per sq. in. the head broke diagonally through the manhole.

The author suggests that boiler and tank manufacturers (and insurance companies covering these installations) take strain-gage readings on their products when completed, and at such other times after they have been put in service as may be possible, and the following procedure is suggested.

Drill the gage holes in the shop, and take readings at working pressure and the test pressure while under test. At times of annual inspection have readings taken by those in charge of the vessels or by the insurance inspectors.

The schedule of the tank tests to be made jointly by the American Welding Society and the A. S. M. E. should include tanks made with various designs and locations of manholes, and these should be examined with special care.

In all these cases the stresses at the knuckles of the heads should also be measured wherever and whenever possible, as the formulas for these radii are apparently equally as arbitrary and incorrect as are those for manholes.

The ruptured head was cut off with a cutting torch about two inches beyond the head girth weld and sent to the Union Carbide and Carbon Research Laboratories for investigation and study. After careful consideratfon by all those interested, it was decided that the best method to pursue in the investigation was to take tensile test pieces from various parts of the head to see if any change had been made in the physical properties by the various processes to which the head had been subjected. It was also decided that sections should be cut from various parts of the head to determine what change in thickness had been caused by the flanging operation, and that a number of macro and micro sections should be examined, as they might explain changes in physical properties, as well as show the general quality of the welds. Chemical analyses were also decided upon, to be made from the head, the shell, and the manhole flange. The general location of the test pieces is shown in Fig. 2.

The letter preceding a number may be termed a classification letter, and the number indicates the serial number of the test piece, several of each kind being taken in order to get a fair average from similar locations in the head.

The "A" pieces were taken longitudinally of the tank and the "B" pieces close to them radially of the tank. There were four of each.

The "C" pieces taken in the head as close as possible to the bottom of the vee of the girth weld in order to determine any effect that the heat might have had on the base metal. There has been considerable discussion in the past in regard to this heat effect, and this appeared to be a good opportunity to obtain some exact information. There were also some pieces marked "C-A" that were taken from the weld metal in order to see what its characteristics were, and to determine as closely as might be whether the welding had been well done. These pieces were taken from the same sections as had been cut out for the "C" pieces and less than one inch away from them, as shown in the small view in Fig. 2.

Two pieces marked "D" were taken from the head close to the ends of the major and minor axes of the manhole. There was probably more welding heat applied here than at any other place, and it was thought that if any effect therefrom were to be found it would be there, and might be noted by the microscope. In addition to this there would be but little, if any, effect such as exists when a weld is of the double-vee type, in which case the grain of the first side welded is refined by the welding heat from the second side. It was also considered important to know if the stretching that had occurred at the manhole had affected the strength of the material at that point.

The three "E" test pieces were taken at a point as remote as possible from any welding heat, about half-way between the flange and the manhole. It was thought that these would offer a good basis for comparison.

Two pieces marked "F" were taken from the flange of the manhole plate, to get some idea of the physical properties of the metal, as it was not of exactly the same characteristics as the head and shell.

The "G" sections were taken to show the change in thickness of the metal due to flanging. There were three of them. For the same reason the two "H" sections were taken.

The section marked "I" was taken entirely through the flange of the head, the weld, and the shell, partly to determine as accurately as possible the radius to which the head had been distorted. It was taken at a point where the least distortion due to the rupture had occurred.

There were two sections taken marked "J" for the purpose of determining if any residual stresses could be found due to the weld. It was doubted that this could be done because of the permanent set that had been undergone by the head during the testing, but it was considered worth trying. All these sections were cut out with the cutting torch, but were cut very large in order to remove any possibility of the heat causing any effect on the metal.

The head was intended to be 1¼ in. thick, but in no case was this dimension obtained in the spherical part of the head, although the minimum thickness is only about 0.04 in. less than ¼ in. In general, the head seems to have thinned down in the spherical part and to have gradually thickened up toward the knuckle, until an increase in thickness is seen amounting in section "I" to 0.18 in. at the end of the flange.

The general impression has been that the material is thinned down at the knuckle by the flanging operation; and this may be true when the flanging is done at one stroke by complete dies in a flanging press, which is the practice always followed in large shops for production. It is, however, general practice in any shop where only one or two heads are needed, to use a sectional flanging press to do the work, and if the opera-

tion of such a machine is considered, it appears that there is an upsetting of the metal at the flange as it is gradually turned, instead of the stretching which would be expected to occur when the head is forced at one time through a circular die.

It therefore appears that this matter should receive further consideration, and that in each case the type of machine used and the method followed in making the head should be known.

As to the effect on the welding of this thickening of the flange, it seems to emphasize the necessity of more beveling of the head on the inside so that the section of the vee on the head and on the shell are closely the same, especially with heavy plate.

The results of the tensile tests show that all of the test pieces from the head, regardless of their position, meet the requirements of firebox and flange steel in the Boiler Code in regard to tensile strength, yield point, and elongation, with the exception of test piece "A-1," which fails in the elongation by only 0.8 per cent. All of the reductions of area are also entirely satisfactory.

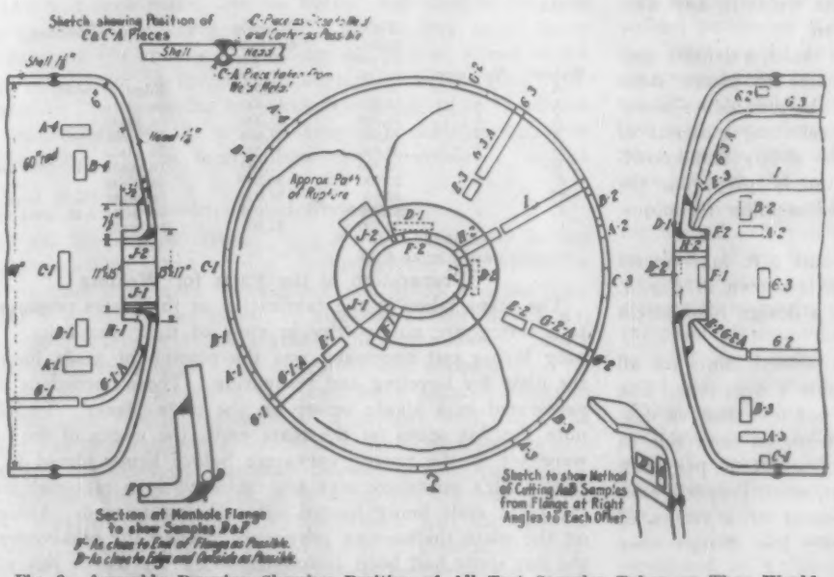

Sketch showing Position of C & C-A Pieces
Shell
Head
Approx Path of Rupture
Section at Manhole Flange to show Samples B & F
Sketch to show Method of Cutting A & B Samples from Flange at Right Angles to Each Other

Fig. 2. Assembly Drawing Showing Position of All Test Samples Taken as They Would Appear in Tank Head Before Rupture.

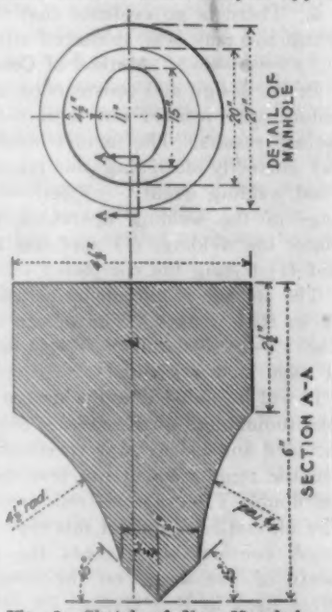


Fig. 3. Sketch of New Man-hole Reinforcing Ring.

The results of the "C" specimens show that, at least in double-vee welding in plate of this thickness, there is no change in the physical properties of the metal due to the welding heat. For many years one of the arguments of those opposed to welding has been that the base metal next to the weld must be injured by the welding heat. These results seem to show that there is no such effect.

In a number of instances, especially in the "D" and "E" test pieces, the yield point is considerably higher than in the case of the other pieces. The "D" pieces were taken close to the edge of the manhole and both the tensile strength and the yield point are higher than the rest of the plate, while there is some decrease in the elongation and reduction of area. It should be remembered that the area from which these pieces were taken was heavily cold-worked by the stretching, and while the microscope shows no particular evidence of this distortion, yet it is well known that stretching beyond the yield point produces the results given by these test pieces. Therefore, while there is no definite proof of the cause of these changes in physical properties, it is not unreasonable to suppose that they are due in large part to the cold work, and it is perfectly safe to say that at least the material has not been injured.

In considering this matter of strength it should be remembered that the whole head was badly distorted even before it ruptured, and that the rupture increased the distortion in many places. It is of course impossible to say how much distortion to have broken approximately in the center of the reduced occurred at any one place due to the rupture, but it is quite possible that the change in physical properties of the "E" pieces can also be partly explained by the cold work occurring from this distortion, although no definite conclusions can be stated.

The manhole flange shows somewhat less tensile strength and yield point than, and about the same elongation and reduction of areas as, the head, and the macroetching shows that they are of about the same quality, there not being enough difference between them to comment on.

The specimens taken from the weld metal show good strength and quite satisfactory properties, and are much better than many would expect. While most of these samples appear section of the tensile sample, a few of the breaks appear to have been initiated at some slight defect. It must not be forgotten that such defects are not the same as those due to a serious lack of penetration or uniformly poor fusion, but that they are small and local and have but little effect on the strength of the structure as a whole. It is also true that similar small defects are common in steel plate and that definite allowance is made for them in all standard specifications.

The examination of the "J" pieces does not give any definite information. The figures show that in all except one case, the radial and tangential stresses were opposite to each other as would be expected, but in many cases they are so different in value that they could not be considered of definite import. It must also be remembered that the removal of the pieces may have introduced some stresses, although care was taken to cut them as large as possible. With the same exception as referred to before, the stresses in the head and in the saddle plate are opposite to each other in sign, although widely different in value.

A few photomicrographs were taken from the tensile-test-piece stubs. There is no serious difference in the structures except in one, taken from the weld metal, in which the structure is coarser as would naturally be expected. The weld metal seems to have about the same carbon content as the base metal. It would also be expected that the metal just next the weld would be somewhat coarser, and this is the case, although the grain is finer than might be looked for. The structure being quite regular, although having some patches in which the pearlite is distributed differently from what it is in most of the area, would seem to account for the lack of change in the physical properties. A photograph taken from

the manhole flange shows a much more strongly banded structure than either the head or the shell, and apparently contains less pearlite than the head; the chemical analysis confirms this belief.

The conclusions drawn from the examination of the ruptured head are:

1. The weld metal (nickel steel), shows ample strength and other physical properties.
2. The base metal next the weld was not injured by the heat of welding.
3. There was no significant difference in physical properties of the metal in different parts of the head.
4. The welds were of good quality, and the fusion and penetration were satisfactory from a production standpoint.
5. There is no evidence that the 1,000 lb. test pressure to which the tank was subjected affected the welds in any way.

Method of Construction

In the design and construction of these tanks, a definite procedure was worked out with the fabricator to insure satisfactory results. The factors involved in this procedure were: (a) correctly designing the joints, (b) selecting material of good welding quality, (c) determining the ability and knowledge of the welding operators, (d) properly preparing the plates for welding, (e) applying approved welding technique, and (f) testing the completed joints.

The storage requirements called for a tank 5 ft. in diameter by 43 ft. in length. The design adopted is shown in Fig. 1. The 1⅛-in. shell thickness was based on a design fiber stress of 8,000 lb. per sq. in.

It will be noted that the design of the welded joints for all longitudinal and girth seams is of the double-V butt type. The included angle of V was specified to be not less than 90 deg. and the reinforcement not less than 3/16 in. on each side of the double-V, or a total reinforcement of about 30 per cent. The ultimate strength of this type of joint, when properly executed, considerably exceeds the requirement of a factor of safety of five based on the comparatively low design fiber stress used in this instance.

The fillet welds joining the manhole reinforcing ring and manhead were so designed that their shearing and tensile strengths were greater than the tensile strength of the material removed from the head. (The unit shearing and tensile strengths of the weld metal were figured conservatively at 30,000 and 40,000 lb. per sq. in., respectively.) The welded connections were also designed to permit satisfactory welding and to provide ample area of weld metal.

Another point in the design which should be noted is the location of the welded seams. It will be observed that the longitudinal seams are staggered 180 deg. Where two longitudinal seams are used per course the seams should be staggered 90 deg., and when three seams per course are used, the angle between adjoining welds should be 60 deg.

Selection of Material

In order to insure the quality of the material used, firebox steel with a maximum carbon content of 0.20 per cent and a minimum tensile strength of 50,000 lb. per sq. in. was specified. The specifications also called for the use of nickel-steel welding wire conforming to the American Welding Society specifications.

The following is a copy of the mill report on the steel used:

Size of Plate, In.	Chemical Analysis C	Mn	P	S	Physical Properties: Yield point, lb. per sq in.	Tensile strength, lb. per sq. in.	Elongation in 8 in., per cent
1⅛×82½ diam.	0.18	0.42	0.011	0.030	36,500	57,440 58,130	30.25
1⅛×82½ diam.	0.18	0.46	0.010	0.027	33,540	52,400 54,130 50,430	29.50
1⅛×96¼×198¼	0.18	0.35	0.013	0.033	34,140	52,320	31.00
	0.18	0.35	0.013	0.035	30,850	52,970 53,480	32.50
	0.18	0.35	0.013	0.035	32,270	51,060 52,730	30.75
	0.18	0.35	0.013	0.033	33,650	51,160 53,650	29.75
	0.18	0.35	0.013	0.033	34,420	52,050 53,140	31.50

Check of the Welders

As a check on their ability to meet the welding specifications, each operator was required to pass a qualification test. The test included the welding together of two sections of 1⅛-in. plate, beveled and set up in accordance with the specifications. Three standard coupons were cut from each weld specimen and pulled in a tensile testing machine. The requirement for passing this qualification test was that none of the coupons should show an ultimate strength of less than 45,000 lb. per sq. in. of plate section.

None of the operators engaged in the plant at which the tank was fabricated had ever welded plate above ¾ in. in thickness. With a small amount of practice under proper supervision, however, each of the welders easily passed the qualification test. The following table indicates the results of the tensile tests.

Welder	Specimen	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Fracture
A	1	31,760	46,300	Edge of weld
A	2	35,000	54,400	In plate
A	3	36,200	53,300	In plate
B	1	30,600	47,600	In weld
B	2	35,420	54,200	In plate
B	3	35,400	53,500	In plate 1 in. from weld
C	1	33,000	50,700[1]	In plate
C	2	32,600	54,000	In plate 1½ in. from weld
C	3	31,200	50,200[1]	In plate 2 in. from weld
C	4	32,500	51,300	In weld

[1]Reinforcement ground off.

Preparation of the Parts for Welding

The steps taken in the fabrication of the plates preparatory to welding are noteworthy in view of their simplicity. The only laying out necessary was the placing of guide lines on the plate for beveling and resquaring. These operations were performed in a single set-up on the plate planer. To eliminate the flat spots on the plate ends, the edges of the plate were set to the proper curvature before being placed in the rolls. This operation was accomplished in a sectional press, the plate ends being heated before being formed. Although on the plate thicknesses previously welded the elimination of the flat spots had been accomplished by the use of jigs when lining up the girth seams, it was thought inadvisable to rely on this method of obtaining the proper curvature because of the stiffness of the heavy shell plate used in this instance.

Following the rolling operation, the abutting longitudinal seams were fastened by means of wedge clamps and then moved to the portion of the shop where the welding was to be done. Prior to welding each of the longitudinal seams, one end was tack-welded and the other separated the required distance to provide for contraction. For tacking, a spacing of ⅛ in. was used, and a tack weld made about 1 in. in length. When necessary a turnbuckle was employed to obtain the desired spacing. The spacing of the seam for welding was secured by inserting a wedge at the open end and spreading the plate edges about two inches at this point. This provided an allowance for contraction during the welding of ¼ in. to the foot.

Welding Longitudinal Seams

In joining the longitudinal seams, the welding of the outer V was accomplished first, being carried on without interruption from start to completion. Three operators alternated on two seams so as to provide a 15-minute rest period after each half-hour of welding.

The method of allowing for the contraction of the seam during welding proved entirely satisfactory. After the weld had progressed a short distance, the wedge clamps were removed and the contraction of the seam controlled by the use of a wedge and a "C" clamp inserted at the open end of the seam. The wedge was manipulated so as to maintain a spacing of about $\frac{1}{16}$ in. between the plate edges a foot ahead of the point of welding. By doing this a constant spacing of about $\frac{1}{16}$ in. was secured at the point of welding. This provided a sufficient opening to secure thorough penetration easily without slowing up the welding operation, as occurs when too wide a separation exists at the bottom of the V.

Preheating from the inside of the seam by the use of an oil torch was tried but soon discontinued. The improvised preheating arrangement was difficult to control and caused considerable discomfort to the welders. Therefore, when it was discovered that the outer V could be welded without preheating, this supplementary operation was eliminated. The course was tilted at an angle of about 15 deg. to facilitate the building up of the required weld reinforcement.

After completing the seam from the outside, the inner V was chipped out to remove the oxide and excess metal which had penetrated to the inside of the seam without becoming thoroughly fused with the base metal. In welding the inner V it was found necessary to resort to preheating since the size of tip used, a No. 15 Oxweld, did not give sufficient heat to fuse the base metal with reasonable speed after the outer V weld had been made. An oil burner was used as the preheating medium, it being aligned in such a way as to direct the flame on the outside of the seam about 4 in. ahead of the point of welding. A forced draft supplied from the shop compressed-air lines provided sufficient ventilation to carry off the heat radiating from the weld making it possible to carry on the welding without interruption or inconvenience to the welders.

Reforming and Annealing

All the longitudinal seams were welded essentially in the manner indicated above. Upon completing the welding of the fifth course(they were checked for roundness and then annealed to eliminate any locked up stresses. Where necessary, the ends of the courses were heated and hammered to secure the required roundness. The annealing was accomplished by heating the entire length of the seam for a distance of about 1 ft. on each side of the weld to a uniform dull red. The course was then removed from the fire, the heated section covered with dry ashes and the seam allowed to cool slowly.

These operations had not been employed on any of the tanks previously constructed as experience had justified the decision that annealing of welded seams in general is unnecessary. In this instance, however, these precautionary measures were taken because of the heavy plate used.

Lining Up and Tacking Girth Seams

The lining up of the girth seams was accomplished by the use of the same wedge clamps previously mentioned in connection with the lining up of the longitudinal seams. The courses to be joined were first set up on rollers and the adjoining longitudinally welded seams staggered as required. The wedge clamps were then inserted at equidistant points of about 8 in. along the entire seam. A spacing of ½ in. between the abutting plate edges was employed, and the wedge clamps manipulated until the seam was within ¼ in. of true alignment at all points on its circumference.

It was then tack-welded at four points. Two welders working at points 180 deg. apart, one on the top welding on the outer V and the other within the shell welding on the inner V, made two tack welds simultaneously. The shell was then turned through 90 deg. and the other two tack welds made. Each tack weld was about four inches in length and without reinforcement.

Welding Girth Seams

The actual welding of the girth seams was accomplished in much the same manner as were the longitudinal seams. With the exception of one seam, the outer V was welded first without preheating and the inner V next, using the oil torch for preheating the seam from the outside.

Instead of tilting the course, as was done on the longitudinal seams to simplify the building up of the required reinforcement, the welding puddle was kept at an angle of from 10 to 15 deg. off center by turning the shell on the rollers as required. The welder, furthermore, instead of moving along the seam as it was welded, remained in one position and had the tank turned to suit his convenience.

The method of providing for contraction was also considerably different from that employed on the longitudinal seams. In the latter case, it will be recalled that the seam was spread at the open end and allowed to contract as the weld progressed. In setting up the girth seams, however, the abutting plate edges were spaced equidistantly along the entire seam and wedge clamps inserted at small intervals to retard the movement of the plate edges during welding. The four tack welds were made to prevent any undue contraction at one point and expansion at another.

It would appear that this method of providing for contraction by preventing it would tend to lock up the contraction stresses and thus give trouble. Since, however, a spacing of ½ in. was provided before tacking, the weld was allowed to contract in small increments and the effect of this contraction was largely prevented from being transmitted to the unwelded portion of the seam because of the wedge clamps and tack welds used. This method therefore prevented the locked-up stresses from building up in such magnitude as to give any trouble. In welding the second side of the double V, furthermore, the locked-up stresses caused by welding the first side were largely dissipated through the reheating of the welded area both by the oil torch and the oxyacetylene blowpipe.

The application of this method was carried on in the following manner. The wedge clamps were removed for a distance of about 18 in. from the starting point of the weld. As the weld progressed, other wedge clamps were removed in such a way as to maintain a spacing of about ¼ in., a foot ahead of the point of welding. To do this it was sometimes necessary to weld up to within about 4 in. of a wedge clamp before removing it, and the upright portion of the clamp, in this case acting as a wedge, had to be removed by cutting it out with the blowpipe. As the weld approached one of the tacks, however, the spacing between the plate edges naturally increased, and it was therefore a comparatively simple matter to control the contraction.

Following this method of procedure little difficulty was encountered in welding the six girth seams. At no point did the plate edges overlap, and for the greatest portion of the seams, the spacing between the plate edges varied from $\frac{1}{16}$ to $\frac{1}{8}$ in.

Welding Saddle Plate to Manhead

In welding the saddle plate to the manhead, the two pieces were first tack-welded at the four corners of the outer flange of the saddle plate. This was accomplished while the head was in a horizontal position and after the saddle plate had been properly aligned with respect to the hole in the manhead.

After tacking, the manhead was tilted at an angle of about 20 deg. and the welding started at a point adjacent to one of the tack welds. The oil torch was used to provide additional heat in the vicinity of the point being welded. The welding progressed until the second tack weld was reached. The head was then turned, the welding started in the opposite direction and continued until the seam was completed. This change in direction of welding was pursued in order to reduce the locked-up stresses and minimize the tendency of the saddle plate to lift up from the head.

The seam having been completed from the inside, the head was turned over and the outside weld made. This seam was welded continuously in one direction but otherwise the procedure followed was the same as employed on the inner seam.

The welding of the nipples and other connections was carried on in accordance with regular accepted practice. Because of the considerable difference in thickness between the shell plate and pipe walls, however, the plate had to be preheated to a bright red before the blowpipe flame was allowed to impinge on the surface of the connection being welded.

The examination of the head proved conclusively that the

(*Continued on page* 48)

Expansion in Welded Pipe Lines

Seasonal Soil Temperature Changes Will Not Cause Breaks if Slack Is Provided at Time of Laying Pipe

ENGINEERS in the natural gas industry who are interested in the building of main pipe lines have turned their attention more and more in recent years to the welded joint. One of the problems in pipe line work is that of providing slack in the line to take care of expansion and contraction. This subject was discussed at the annual meeting of the Natural Gas Association, held at Tulsa, Oklahoma, May, 1926. The principal part of the discussion was furnished by

Rolling Long Section to Align for Tie-in Weld.

Mr. Lege, of the Magnolia Company, describing the method used in the construction of an eighteen-inch pipe line, two hundred and fifteen miles long. Following is a copy of the paper prepared by Mr. Lege:

In laying welded large diameter gas lines, great care must be exercised to insure getting the lines into the ditch under compression. To accomplish this, several methods of providing for slack in the line may be used.

Ready to Lower a Section of the Line.

The old method of wallops in the line is not as satisfactory as it is with smaller pipe, as the large diameter lines are much stiffer, and an effective wallop hard to secure.

A sinuous line would be most satisfactory, if it were possible to hold the line sinuous until it was lowered into a straight ditch and to prevent the slack so secured being shoved ahead of the line. Difficulty has also been found in laying large lines sinuous as the expansion caused by the heat of the sun during the day and the contraction caused by the lowered temperature during the night forces practically all the slack out of the line before it can be lowered into the ditch.

I believe the most satisfactory method of securing and holding slack in large lines is that of distributing logs, blocks or other suitable objects every one hundred or two hundred feet, the distance depending upon the size of the blocks, and laying the line on top of same, thereby raising it from the ground twelve to twenty-four inches, relying upon the weight of the pipe between the blocks to hold the slack so placed in the line. The line may then be lowered into the ditch during the early forenoon, with skids distributed where the blocks were formerly placed, after which it can be covered between the blocks, and the blocks removed during the night, to allow the line to settle into the ditch sufficiently to be covered. Unless the skids are placed across the ditch and the line is held up at regular intervals, the slack secured by use of the blocks will crawl ahead and will be lost for the purpose it was intended, and the line will have to be cut, as there will be more slack than can be placed in the ditch.

Welding Bull-Plug on End of Section for Testing.

In East Texas, the temperature of a pipe line during the summer seldom exceeds eighty-five degrees Fahrenheit, and in the winter seldom goes lower than thirty-five degrees Fahrenheit. Therefore, the differential in temperature, which governs expansion and contraction, will seldom exceed fifty degrees Fahrenheit. Inasmuch as the expansion of steel pipe is .38 inch per 100 feet for each fifty degrees Fahrenheit, it will be necessary to provide not to exceed twenty inches per mile slack to take care of this factor, and only half that much if the line is laid while the temperature of the line is around sixty degrees Fahrenheit.

Where lines are laid during the summer, and the temperature of the pipe at the time it is lowered into the ditch is greater than eighty-five degrees Fahrenheit, there will, of course, be a proportionately greater number of inches of slack to be provided for, due to the expansion. However, it must be remembered that the country traversed by a pipe line is seldom level, and practically all the necessary slack can be taken care of by crotching the line over all high points and ditching it deeply in the valleys.

Due consideration should also be given to the elasticity of the steel, and where the line crosses long, steep hills, great care should be taken to be sure that compression exists on both sides of the hill; otherwise trouble may be experienced, due to the weight of the pipe causing a strain at the top of the hill.

The use of expansion joints or couplers, I think, is unnecessary and would only be a source of trouble. Our experience on many miles of both sixteen and eighteen inch pipe, that was laid under compression, shows that, with only a fairly good weld, no trouble will be experienced from expansion and contraction, with a variation of as much as sixty degrees temperature. On the other hand, where bad rod is used or poor welding is done, the least bit of contraction will cause the weld to crack.

Our experience with both long and short sleeve couplers convinces us that the couplings permit the line to crawl in

Acetylene Piped From Generators Mounted On Trucks.

very much the same manner as it does when laid sinuously, from the effects of the day's heat over the night's coolness. And, as a result, the pipe works beyond the elasticity of the rubbers in the couplers, which frequently causes leaks; whereas, with a line properly welded throughout and lowered under compression, both expansion and contraction are equally distributed over its entire length and give no trouble at all.

It is my opinion that the manner in which a large diameter welded gas line is placed in the ditch, with regard to compression, is of equal or greater importance than are good welds, as I am convinced that a poor weld will hold under compression when it would break on a tight line.

Have your ditch at least six inches wider than your pipe is thick, and at least twenty inches deeper than the thickness of the pipe, so that the pipe can seek its position without binding, and lower it so it will be sinuous in the ditch and you will not experience any trouble, due to contraction.

In conclusion, I wish to state that we are not and do not contemplate using any expansion joints in either our oil or gas welded lines, regardless of size.

ELECTRIC LOCOMOTIVE BUILDERS USE WELDING

A recently published description of the construction of electric locomotives shows that the transformer tanks of these locomotives depend largely upon welded steel for tightness. The vertical seam of the transformer tanks is welded and also backed up by a strip fillet welded to the inside by the full length of the seam, giving a triple welded seam effect. The bottom of the transformer tank is riveted to the side and the joints between the bottom and the side is closed with a fillet weld done in layers. The inside corners of the liquid rheostat are reinforced by angles riveted and triple welded. This job calls for the best welding procedure because the tank has to hold hot oil without leaks.

PHILADELPHIA SECTION ELECTS OFFICERS

At the annual meeting of the Philadelphia Section of the American Welding Society, held April 17, new officers were elected for the coming season, as follows:

Chairman, R. D. Thomas.
Vice-Chairman, J. J. Dunn.
Treasurer, Clifford Bates.
Secretary, H. E. Hopkins.
New directors are: C. M. Rusk and Thomas A. Jones.

DISCUSSION ON WELDED PRESSURE VESSELS AT CHICAGO A. W. S.

Mr. S. W. Miller, research engineer of the Union Carbide and Carbon Research Laboratories, gave an interesting and instructive talk on "The Design and Testing of Welded Steel Tanks and other Pressure Vessels" at the May meeting of the Chicago section of the American Welding Society. Mr. Miller is well qualified to speak on this subject and gave some worth-while information as the result of his research in this field.

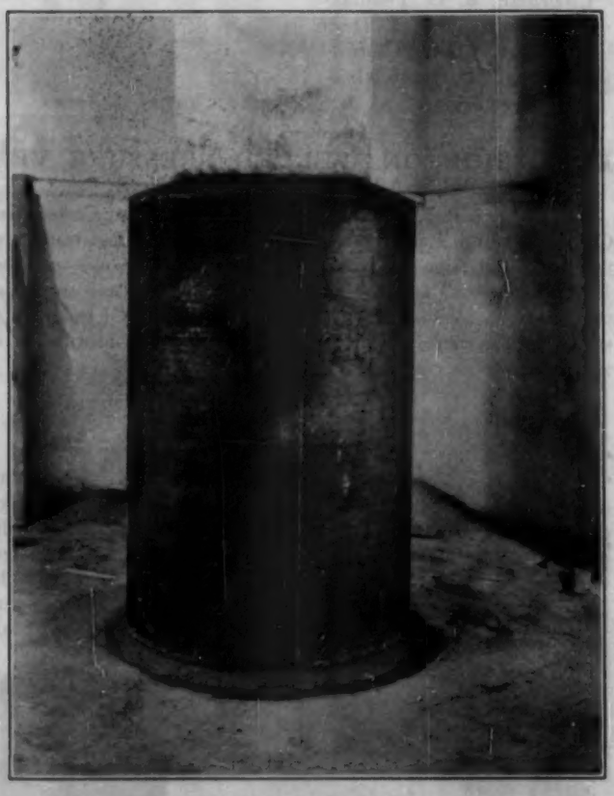
WELDED STEEL SHELL PROTECTS CONCRETE COLUMN

Owners of plants in which there are concrete columns or parts of columns exposed, may get a suggestion from a job recently completed by the Paxton and Vierling Iron Works of Omaha, Nebr. One of the accompaning photographs shows a damaged reinforced concrete column in a cold storage plant in Omaha. This column was damaged by constant bumping with hand trucks and soon reached this stage, which called for some sort of repair.

What Trucks Did to a Concrete Column.

The first suggestion made was that the situation called for not only a repair, but some means of protecting the column from further damage of this sort. It was finally decided to weld a steel shell large enough to go around the column and fill it with concrete. The steel shell is 42 inches inside diameter and the concrete column is 30 inches outside diameter. The steel shell is made of 72-inch by ¼-inch plate, sent to the job in two halves, rolled to shape, welded at the building inside and out with an

electric arc welder. After welding the shell was filled with concrete. This shell extends one foot into the floor concrete of the building and approximately 3 feet about the damaged portion of the concrete. The second illustration shows the appearance of the



How Column Was Made Bump-Proof By Welding.

finished job, and from this it is quite evident that a simple welding job had not only repaired the column, but has provided it with pretty good insurance against future damage.

PRESSURE VESSEL WELDING

(*Continued from page* 45)

welds were in no way responsible for the failure as they were all intact except as severed cross-sectionally together with the saddle plate and manhead. On the other hand, this failure proved much in favor of the welded joint, the manhead girth weld and the longitudinal weld in the course adjacent to the manhead being in no way affected.

Design of New Manhole Reinforcing Ring

In the repair of this tank it was not only necessary to remove the defective head and reweld a new manhead, having in it a manhole reinforcing ring of the requisite strength. The design of the new reinforcing ring, a sketch of which is shown in Fig. 3, was developed by the engineering department of the Linde Air Products Co. Because of the high test pressure to which the tank was to be subjected, a cover plate designed for a working pressure of 450 lb. per sq. in. was specified.

The new manhole reinforcing ring was produced from a steel slab, having the seme chemical and physical properties specified for the shell plate. The slab was first cut by means of an oxyacetylene blowpipe to circular shape and then machined as required to produce the desired fillet and welding bevel. The elliptical manhole was cut out by means of an oxyacetylene blowpipe and the edges of opening ground smooth.

The new manhead was constructed in accordance with the previous design, except that an 8-in. flange was specified to replace the metal removed from the first course in cutting off the defective head. After the head had been formed, however, it was necessary to remove a larger section from it than had been done on the previous head as the new manhole reinforcing ring was designed for butt welding to the head rather than lap welding as had been employed in the previous construction.

Welding New Manhole Reinforcing Ring to Manhead

The reinforcing ring was first set up and leveled at approximately the height required for attaching it to the manhead. The manhead was then lowered into position and after being blocked up to provide for a draft during preheating, was shimmed as required to bring the abutting edges of the reinforcing ring and manhead into alignment.

Four tack welds were next made at equidistant points on the seam, each two being made simultaneously at points 180 deg. apart. These tack welds were about four inches in length and without reinforcement.

After the tack welds had cooled, a firebrick preheating furnace was built about the entire head. This furnace was constructed in such a way as to provide the greatest amount of heat at the seam to be welded and in the heavy section of the manhole reinforcing ring. A natural draft was provided, entering through the openings between the blocks on which the head was set up and leaving through the elliptical opening in the reinforcing ring. Charcoal was used as the preheating medium, being distributed within the furnace through the elliptical opening. Asbestos paper was employed to cover the exposed section of the head.

Preheating was carried on until the manhole renforcing ring and head in the vicinity of the weld had been brought up to a dull red. Welding was then started, using a long-handled blow-pipe to keep the welder away from the heat.

After completing the weld from one side, all openings in the furnace were shut off and the head allowed to cool slowly and uniformly to room temperature. The excess metal was then chipped from the inner V as had been done on all other seams. Following this operation the head was set up for welding the inner V. It was then again preheated and welded. In order to eliminate any locked-up stresses, the head was completely annealed by placing it in a forge fire, bringing up to an even heat and allowing it to cool slowly and uniformly.

Rewelding Manhead to Shell

The new manhead was welded to the shell by the same method as employed on the last girth seam previous to the head failure. A forced draft was maintained against the head, however, when welding the inner V, to carry away the heat generated and maintain a low enough temperature to permit entrance to and emergence from the tank through the manhole.

Retest of Tank

The rewelding of the manhead girth seam having been completed, the tank was again subjected to the same tests previously indicated. Following the initial test in which the head adjusted itself somewhat to the theoretical elliptical shape, a reapplication of the pressure indicated that the stress in the head and manhole very closely approximated the design fiber stress. The tank was therefore accepted as safe.

A secondary test for gas tightness was next applied, the tank being subjected to an air pressure of 450 lb. per sq. in. Under this pressure all the welded seams were tested with soapy water, but not a single leak was discovered. The tank was therefore accepted and shipped to the customer.

No one will take issue with the statement that this tank is perfectly safe for operation under the designed working pressure. Welded-tank construction carried on since the completion of this tank has furthermore proved that the results obtained may readily be duplicated even when using a design fiber stress of 9,000 lb. per sq. in. From their knowledge about the performance of small tanks, the author's company had convinced themselves that a much higher fiber stress could be used than had been recommended in current codes. When the

problem of constructing large pressure vessels was presented, a gradual development was made, and by controlling the factors involved, it has been proved that size had no effect on the results obtained.

In the plant at which the tank under consideration was constructed, the welding of large pressure vessels has become a part of the regular production work. Procedure control methods have been thoroughly installed and this fabricator is now in a sound position to carry on welded-pressure-vessel work. Nor has the procedure adopted involved any regulations which would not be practical for any shop to adopt.

Many others interested in welding have come to the realization that uniformly successful results may be obtained in welded construction by the control of the factors involved, and as the development work carried on in this direction during the past few years is more generally appreciated, it is only logical to assume that engineering bodies and purchasers of pressure vessels will modify their ideas to permit a more liberal use of the inherent strength of welded joints.

A BOOKLET ON STEEL BY A. I. S. C.

"Steel Never Fails" is the title of an elaborate booklet issued by the American Institute of Steel Construction, which proceeds to show in convincing fashion, assisted by apt illustrations, the fourteen reasons why, which are as follows:

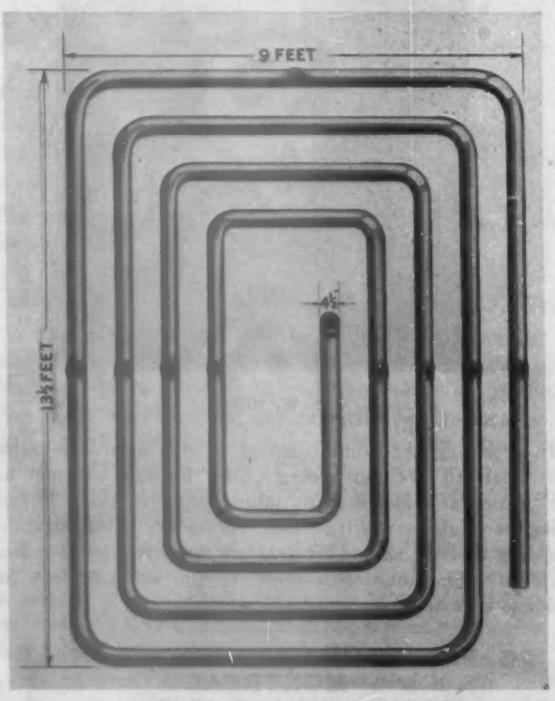
1. Strongest building material known to man.
2. Safe——most homogeneous structural material.
3. Permits highest speed in construction.
4. Occupies least space per unit of strength.
5. Incombustible—reduces fire hazards.
6. Permanent.
7. Combines greater strength with higher elasticity.
8. Permits rapid and inexpensive alterations.
9. Quality is uniform.
10. Can be erected in any weather without protection.
11. Will stand more abuse than other material.
12. Weighs least per unit of strength.
13. Highest salvage value with low removal cost.
14. Produced by responsible concerns.

BUTT WELDING PIPE FOR OIL EQUIPMENT

Few industries can compete with the oil refining industry in the demand for all welded pipe shapes. The equipment and machinery used in the refining of oil has caused the use of almost an endless variety of pipe shapes and combinations. Consequently it is not surprising that the oil companies are large users of welding and that they have been obliged to investigate all of the welding processes and their applications. Welded pipe joints have two advantages in oil refinery equipment. One is that it is the least expensive method of fabricating pipe shapes, the other is that by securing an absolutely leak proof and dependable joint the oil men are able to eliminate a great deal of hazards connected with the production of gasoline. Some idea of the importance of good joints in this work may be gained from the fact that in the cracking process, under certain patents, a temperature of 1000 deg. and a pressure of 500 lbs. per square inch is called for. The illustration shows a piece of apparatus which is called afsill coil. These coils are formed of 4-inch extra heavy drawn steel tubing having a cross section of 4½ square inches, and there are eight welds in each coil. The coil when completed is nine feet wide by thirteen and a half feet long, and weighs 1800 lbs.

Engineers connected with one of the larger gasoline producing companies in America became interested sometime ago in the possibility of welding pipe by the electric resistance butt welding process. This process is used extensively for safe-ending tubes in locomotive boilers, and a number of machines have been developed and put on the market for this particular class of work. The engineers from the oil company in the course of their investigation of butt welding for pipe conferred with engineers of the Federal Machine & Welding Company, Warren, Ohio.

The result was the development of the Federal Type Number 90 Butt Welder, which has the capacity for 2½ inches round solid stock or the equivalent of 5 square inches. This type of machine can be operated with a hand clamp but clamping by air or hydraulic pressure is recommended because it eliminates the manual labor when welding heavy material. Motor driven oil gear mechanism can be furnished for supplying the welding pressure. The machine requires a floor space of 5 ft. 4 in. long and 3 feet wide for operation. It is 3 ft. 4 in. high and weighs 6000 lbs. The current capacity is 100 KW. The standard windings are for operating on 220 or 440 volts 60 cycle alternating current pressures, but machines of this type can be wound for any voltage or frequency. The development of this type of welder has made possible a considerable decrease in the production cost of the coil illustrated. The machine completes a coil of 8 welds in 60 minutes, including the time necessary to shift the coil from one weld to another. In other words, the whole 8 welds are made in an average of a little



Still Coil of Butt Welded Pipe.

over six minutes each, including all the handling time. The only preparation of the metal for welding is the exercise of a reasonable amount of care to remove rust and scale at the point where the pipe is gripped by the copper clamp. On account of the high pressure and high temperature to which these coils are subjected in service it is necessary that they be rigidly inspected after welding, therefore as each coil is completed it is subjected to a test of 2000 lbs. per spare inch pressure.

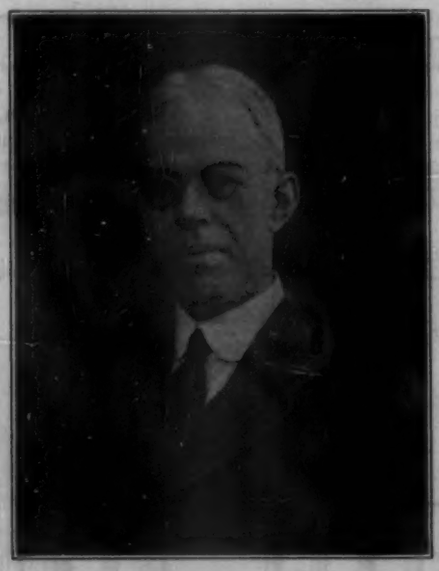
WELDING SOCIETY ANNOUNCES ESTABLISHMENT OF THE MILLER MEDAL

At the Annual Dinner of the American Welding Society held in New York on April 28th, President F. M. Farmer announced the donation of an award, the gift of Samuel Wylie Miller, to be presented by the Society annually in appreciation of work of outstanding merit in advancing the art and science of welding. The award is a gold medal, which will be known as the Miller Medal.

Mr. S. W. Miller has been one of the outstanding figures in the advancement of welding ever since its commercial inception. He is a past president of the American Welding Society, and a prominent and active member of the Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers and other scientific and engineering organizations. He has been long noted for his energetic insistence upon high

quality and dependable workmanship and upon the development of welding by all processes along lines scientifically well founded. Mr. Miller is Consulting Engineer, Union Carbide and Carbon Research Laboratories, Inc.

In establishing this award, the details for the administration of which are not yet decided upon, Mr. Miller's object is to promote an appreciation of better welding and to encourage the study of those fundamentals which will lead to raising the quality of work done by the average operator.



S. W. Miller.

In accepting the administration of this award on behalf of the American Welding Society, Mr. Farmer outlined briefly the history and ideals of its donor, and expressed himself as being particularly gratified that during his administration the Welding Society should be granted the privilege of managing such an important contribution to the improvement of the welding industry.

G. P. A. SUMMER CONVENTION AT MONTREAL

The Board of Directors of the Gas Products Association have announced that the annual mid-summer convention will be held this year at Mount Royal Hotel, Montreal, Canada, on July 13th, 14th and 15th.

Chicago and Western members will probably leave Chicago at 5:40 Monday, July 11th and arrive in Montreal on July 12th at 4:10 p. m.

Wednesday and Thursday will be given over to business sessions and on Friday a trip will be arranged to the Shawinigan Carbide Plant at Shawinigan Falls, 137 miles down the St. Lawrence River toward Quebec.

SUMMER WELDING COURSE AT LANE TECH.

Lane Technical High School, Chicago, has announced a special summer course in oxy-acetylene welding, under the direction of George Colman, who has been in charge of the welding instruction in that school for a number of years. The summer course will run for eight weeks, starting June 27th, and the students will be handled in two sections, the first receiving instruction from 8:00 a. m. to 10:30 a. m. and the second from 10:30 a. m. to 1:00 p. m. The course does not aim to turn out expert welders in this time, but does provide for thorough instruction and practice in the fundamentals of the process. Through the winter months the welding course is given in night school only, so the summer course really provides an exceptional opportunity for beginners to secure training during the day.

ANNUAL CONVENTION OF MASTER BOILER MAKERS' ASSN.

Some of the old-timers were heard to remark that the convention of the Master Boiler Makers, held in Chicago at the Hotel Sherman on May 3, 4, 5, and 6, was the most interesting and successful in the eighteen years of the annual event. Among the numerous practical discussions which filled the first three days was one on "The best and most efficient methods that are being used in the reclaiming and safe ending of boiler tubes and flues." The presentation of the committee's report was followed by a spirited discussion of the relative advantages of the scarf weld versus the butt weld, the committee reporting in favor of the butt weld. All agreed, however, that the practicability of welded flues had been proved not only by pulling tests but by service, and that the electric welded flue is here to stay. While it is apparent that a process of education is necessary for the operators, it was pointed out that all of the early difficulties with welding have been overcome.

The topic, "Standard and recommended practices of fusion welding" was scheduled, but the committee reported that it was not prepared to go before the Association with any recommendations.

Among the exhibits displayed by members of the Boiler Makers' Supply Men's Association were those of Air Reduction Sales Co., Chicago Eye Shield Co., Oxweld Railroad Service Co., John A. Roebling's Sons Co., Thomson Electric Welding Co., Torchweld Equipment Co., and the Winfield Electric Welding Machine Co. Among the exhibits of the Associate Members were The Acetylene Journal and *The Welding Engineer*.

LINCOLN CO. APPOINTS R. D. MALM, WESTERN DISTRICT SALES MANAGER

The Lincoln Electric Company of Cleveland, Ohio, announces the appointment of Royal D. Malm as western district sales manager, with headquarters at Chicago.

Mr. Malm is an engineering graduate from Case School of Applied Science, Cleveland, Ohio, class of 1912.

For four years after leaving school he was engaged in construction engineering and then became identified with

R. D. Malm.

the Elyria Iron & Steel Company. Later he went with the Standard Welding Division of the Standard Parts Corporation as general superintendent.

For the past year Mr. Malm has had charge of Lincoln sales in the automotive industries with headquarters in Detroit.

His wide experience in engineering work has contributed materially to his success in sales work.

LINDE PUBLISHES RESULTS OF TESTS ON BRONZE WELDED CAST IRON PIPE LINES

A thorough study of methods of controlling temperature and bending strains in bronze welded cast iron pipe lines is presented in a very practical booklet recently issued by Linde Air Products Company. It is the result of actual field tests conducted by Linde Air Products Co. in collaboration with the United States Cast Iron Pipe and Foundry Co., for the purpose of studying the problems of buried high pressure pipe lines in service and to determine the conditions necessary to insure a successful installation.

After describing the tests in detail, tabulating the results and illustrating the mathematical formula for arriving at the end movement of a given section of pipe, the conclusions are summarized as follows;

"Bronze welding cast iron pipe lines can be laid with complete assurance of success if precautions are taken to minimize the bending and tensile strains in a long continuous section of pipe. The bending strains can be minimized through exercising a reasonable amount of care in welding, laying the sections straight, and uniformly supporting the line in backfilling. The temperature stresses can be controlled and maintained within safe limits by the proper spacing of expansion joints.

"These conclusions are based upon laying the pipe below the frost line. Very little is known of the nature, distribution, or density of the bending strains imposed by frost action. By spacing expansion joints 100 feet apart, the line is more flexible to resist this bending. The frictional resistance to expansion and contraction probably becomes extremely large after freezing and as contraction is restrained, tensile temperature stresses are imposed by further decrease in temperature. This should not be serious with expansion joints 100 feet apart."

LINCOLN'S "STABILIZER" EXPANDS

The Lincoln Electric Company's, publication, "The Stabilizer" has grown from a four page to an eight page sheet, with new pages under the head, "How I did it!" giving a considerable number of actual experiences and discoveries of "welding minded" operators in the application of arc welding in metal making and using industries.

Here are two typical items taken from the April issue;

". . . . we were called to a job eight miles from the city, and found a 4 inch cast iron ell cracked on a pipe line. To tear the job down and renew would require a lot of time as the line was double, there being a smaller line inside the large and run through brick walls. A new steel ell was sawed in half and V'd out, then we broke the cast iron ell off, clamped the two new pieces in place and welded them. . . . . This was a great saving in time and money as well.

"In our plant we are welding everything possible. We are just commencing to butt weld all smoke stacks. We lay out a pattern sheet with four holes equally spaced around and three in the vertical seam, and fasten the sections together with small pieces of strap iron, then weld up, take off the lugs, and weld up the holes. We find this is a great deal faster than making large and small ends on the sections and lapping them over. . . .

"We make many large elbows from 10 guage to ⅜-in. steel, 1 foot to 4 feet diameter, and are also buttwelding them, fastening the sections together in the same manner as smoke stacks, and we haven't had a single failure.

"We also built a thirty foot self-supporting span bridge, without a rivet or a bolt in it. It stood the floods this spring until the piers were washed out and it was let down. The piers were replaced and the bridge set back up, and not a single weld gave way,—neither did it spring or twist in any way."

GENERAL ELECTRIC TYPE F. ELECTRODE

A new wire for general welding of steel was recently put on the market by the General Electric Company under the name of G E Type F Electrode. It has similar characteristics from a welding standpoint as those of the G-E Type B Electrode, which was introduced to the market sometime ago for automatic electric arc welding. The Type B Electrode however, proves to be a little too fast for handwork. The type F Electrode is a good quality bare electrode, chemically treated so that it has the same characteristics for hand welding, as the Type B fluxed electrode has in automatic arc welding. It is made for hand welding but it can be used on automatic welding as well. One of the features claimed for it is the exceptional stability enabling the operator to do more work with less speed and another feature is the small amount of dissipation of the metal outside of the weld. The manufacturers have developed a special process for treating these electrodes which is said to be so economical that the Type F Electrode can be furnished at just about the same cost as a good quality bare welding wire.

CLEVELAND SECTION, A. W. S., ELECTS OFFICERS

At an election held this month by the American Welding Society, Cleveland Section, the following officers were elected for the 1927-28 season:

A. F. Davis, Lincoln Electric Co., Chairman.

J. C. Lincoln, Lincoln Electric Co., Vice-Chairman.

Otto J. Borneman, Euclid Crane and Hoist Co., Secretary.

Merril H. Turner, Purox Co., Treasurer.

The new officers will meet at an early date to formulate plans for the coming season.

NEW UNDERWATER CUTTING TORCH

Craftsweld Equipment Corporation, 570 Seventh Avenue, New York, has placed on the market a practical underwater cutting torch, the Ellsberg Model S-51, on which patents are pending.

This torch was developed and perfected by Commander Ellsberg, U. S. N., and proved indispensable in the raising of the U. S. S. S.-51 from a depth of 135 feet under water. For this accomplishment Commander Ellsberg was awarded the distinguished service medal.

The performance claimed for the Ellsberg Model S-51 underwater cutting torch is remarkable. It is said to preheat one-inch steel in 5 to 8 seconds, and cut it in 50 to 60 seconds per lineal foot in a depth of more than 100 feet under water.

In cutting steel cables one inch in diameter, the total time reported required for preheating and cutting is only 10 to 15 seconds.

This torch has numerous applications in the various industries, its uses including cutting steel coffer dams, removing submerged obstructions, cutting into steel tanks or vessels filled with water, sectioning submerged structures for easier handling, releasing propellers fouled with anchor chains or cables, for all marine work and for fire fighting, and other purposes.

TUBULAR ELECTRIC FURNACE FOR HEAT TREATING

An electric furnace constructed on an entirely new principle, without heating elements, has been produced by H. O. Swoboda, Inc., consulting electrical and mechanical engineers, 3400 Forbes St., Pittsburgh, Pennsylvania.

A metallic tube, of proper size to accommodate the metal parts to be heat treated, forms the electrical resistor. Outside of the resistor is a refractory tube, well insulated. These, together with the frames, supports, and connections and a metal chute to the oil bath, comprise the entire furnace. Any temperature may be attained up to 1700 degrees F. and the heat is controlled automatically. The metal parts are fed continuously through the tubes at the required rate and temperature, thence directly to the oil bath, vapors from which prevent oxidation of metal while in the furance.

Besides the elimination of heating elements, and the non-oxidizing atmosphere, the inventors claim low operating cost and quick starting and quick control.

ACETYLENE TORCH CUTTING MACHINE HAS NEW FEATURES

A new oxy-acteylene cutting machine, which is flexible enough to handle a wide variety of work, has been placed on the market by the Kutscheid Manufacturing Company, 911-921 West 49th Place, Chicago. This machine consists of a steel beam, made in any desired length, to which is geared an aluminum carriage, movable to any position on the beam by means of a handwheel. With this arrangement, the operator moves along with the torch and can watch the cutting closely.

Kutscheid Torch Cutting Machine.

On the carriage is mounted a protruding arm which holds the torch and which swivels to any angle. The torch is moved laterally along the arm by means of the smaller handwheel. The torch can also be set at an angle for cutting bevel. This combination of movements permits accurate control of the cutting.

The manufacturers claim great economy of acetylene and oxygen with this device. Used in their own plant for cutting one-inch plates, they operate the torch with 10 lbs. of oxygen and 1 lb. of acetylene, the flame leaving a clean edge and a small kerf.

LINCOLN ANNOUNCES NEW ELECTRODE

A new line of "dipped" welding rod is now obtainable from the Lincoln Electric Company of Cleveland, Ohio. This "dipped" steel rod is the result of several years' study in the company's research laboratories and will be known as "Stable-Arc" Welding Rod, and is a companion to the "Kathode" Welding Rod, which has been sold by the same company for many years and is now well known to the welding trade.

The manufacturers state that with this new rod it is possible to go to considerably larger diameters than has been customary in welding rods for metal electrode welding. It is being carried in all sizes up to ½ inch.

It is also claimed that this rod permits of much higher currents than has been used heretofore, with the resulting greater speed. "As labor is by far the greatest factor in welding costs, increased speed means a substantial decrease in welding cost," states the announcement of this new rod. "Not only does the greater heat give greater speed and less cost but also better penetration and a much smoother finished bead. In addition the greater heat obtainable by the higher currents results in an annealing action which increases the ductility of the weld and gives a greater elongation. Current densities of 15,000 amperes and more per square inch can be used. The decrease in the 'splutter' of the arc gives less spattered metal and therefore more actual metal is deposited per pound of rod."

The higher currents are said to give a remarkably clean finished weld and on heavy welds of more than one layer very little brushing or cleaning is necessary between beads.

"Stable-Arc" welding rod is obtainable in standard 50-lb. bundles, wrapped in burlap and in lengths of 14 inches. It can also be secured in longer lengths if desired.

PAPER ON PIPE LINE WELDING ISSUED BY AIRCO

A reprint of a paper presented at the New York section of the American Welding Society by LeRoy Edwards, Industrial Engineering Dept., Air Reduction Sales Company has been issued in the form of a twenty-page booklet, under the title "Pipe Line Welding from the Oxy-Acetylene Viewpoint."

After pointing out the many advantages of a welded joint over a screwed or bell and spigot joint, Mr. Edwards covers at some length the question of selection and training of welders, to insure perfect welds throughout the line. Then in turn, are treated the preparation of material, aligning of pipe, methods of laying pipe and lowering into a ditch, providing for expansion and contraction, and testing of the line. Numerous excellent photographs illustrate the various steps described.

WODACK FACTORY IN NEW BUILDING

The Wodack Electric Tool Corporation recently moved from their Jefferson Street address in Chicago to their own new building, 4627-4629 W. Huron Street, Chicago. This business was founded less than ten years ago by Mr. Oscar P. Wodack and his steadily going business has finally made it necessary to establish larger quarters. The Wodack line of electric tools includes portable electric drills, grinders, reamers, buffers and portable electric saws. The combination electric drill and grinder which makes it possible to do both operations with the same motor is one of the items in the Wodack line which has been particularly popular in welding shops and shops doing general repair work.

NEWS OF THE WELDING TRADE

Slaymaker Electric Welding Co. of Detroit announce the addition to its engineering staff of Mr. R. G. Richards, formerly with the Pitts Welding Co. and Lincoln Electric Co. Mr. Richards brings to his new position a wealth of experience and technical knowledge.

James F. Lincoln, vice president and general manager of the Lincoln Electric Co., Cleveland, has been elected first vice president of the Cleveland chamber of commerce.

On May 2nd The American Brass Company will open an office in the Military Park Building, Newark, N. J. Mr. J. B. Benedict and Mr. L. B. Smith will be in charge and will handle the line of Anaconda copper, brass and bronze products.

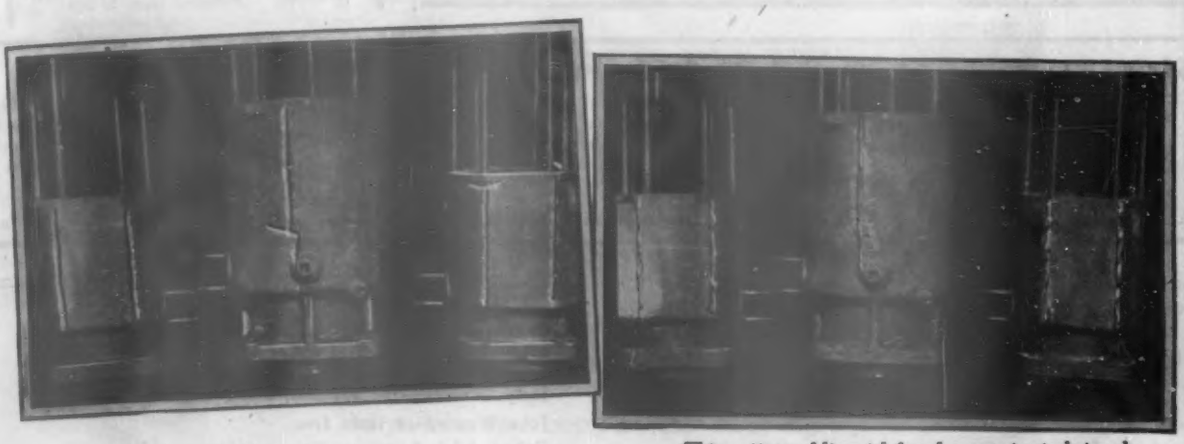
The New York office of Wm. B. Scaife & Sons Co. of Pittsburgh, Pa., has been moved from its location at 26 Cortlandt St. where it has been for 20 years. The new office is in the Architects Building at 101 Park Ave. Metropolitan district sales of the Company's various products are handled from this office by the Manager, H. F. Reynolds.

The Kentucky Oxygen-Hydrogen Company of Louisville, has been awarded a contract to supply a part of the government's helium requirements for the coming fiscal year. Shortly after July 1st, this company will begin to operate a helium production plant at Dexter, Kansas.

Edgcomb Steel Corporation, 350 Frelinghuysen Avenue, Newark, N. J., recently incorporated under laws of New Jersey and organized for the distribution of steel. They are now supplying welding rods, cold-finished steel bars, cold-rolled stripped steel, tool steels, and a complete line of finished steel specialties. The company is housed in a modern up to date steel distributing warehouse at the above address. Officers of the company are men possessing wide experience both in metallurgy and sale of steels, and the company offers expert technical advice and service to the various industries requiring steel and welding rods.

TOBIN BRONZE WELDING

Repairs 3 cracked water jackets in ninety minutes



This entire welding job (one large water jacket and two small ones) required 2½ lbs. Tobin Bronze, 20 cu. ft. oxygen and 20 cu. ft. acetylene.

TOBIN Bronze Welding by the oxy-acetylene process saved time and money on this job. These cylinder water jackets were cracked by freezing. The large one, taken from a 75 H.P. caterpillar tractor, had an 18″ crack. The smaller ones, from 60 H.P. tractors, had cracks averaging 12″ long.

In every case, the cracks were beveled to within 1/16″ of the thickness of the metal and Tobin Bronze Welded without preheating. The entire job was completed in an hour and a half.

Because of the low temperature required, 1650° F., Tobin Bronze Welding usually eliminates preheating, and minimizes distortion and metal shrinkage, thus making it possible to control the alignment. Tobin Bronze permeates the cast iron and knits the broken parts together in a permanent bond stronger than the casting itself. Tobin Bronze welds in cast iron, properly made, cannot break at the weld.

Many manufacturers who have proved the value of Tobin Bronze Welding in repair work are now using it to save time and money, or to improve quality, in their manufacturing operations.

Tobin Bronze Welding Rods may be obtained from distributors of welding equipment and supplies. Look for the trade-mark Tobin Bronze—it is stamped in every rod.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED, New Toronto, Ont

TOBIN BRONZE
Reg. U. S. Pat. Off.
WELDING RODS

EXCLUSIVELY AN ANACONDA PRODUCT

Every Welding Shop Needs This Combination

The WODACK Combination Portable Electric Drill and Grinder soon saves its cost, doing work in half the time that would be required without it. In fact, by doing two kinds of work it saves the price of one tool right away. No shop is too well equipped to profit by the investment in this combination. Write for "Electric Tool Facts," which tells all about it.

Wodack Electric Tool Corporation
4627 W. HURON ST., CHICAGO, ILL.

"WODACK" Combination Portable Electric Drill and Grinder Patented Nov. 1, 1921

"STANDARD" Welding Wire
GAS AND ELECTRIC
A grade for each type of work—send for samples.

for sound permanent welds : : lower costs

Our labor costs are 20% under scale of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished rods—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.
Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

The Commercial Acetylene Supply Company, New York City, announces that after May 1st, the main office of the company will be located at 71 Broadway. The new telephone number will be Bowling Green 5364.

The Air Reduction Sales Company, New York City, has acquired the Interstate Oxygen Company, a West Virginia corporation, with acetylene plants at Wheeling, W. Va., Steubenville, Ohio, and Portsmouth, Ohio; also the Compressed Gas Manufacturing Company, a West Virginia corporation, having an acetylene plant at Huntington, W. Va.

At the meeting of the Los Angeles Section of the American Welding Society which was held on April 28th, Mr. A. E. DeBurn of the Pacific Pipe and Supply Company gave a talk on "Welding as Applied to Pipe Fabrication." After the talk and discussion, those present toured the plant of the Pacific Pipe and Supply Company.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of The Welding Engineer, published monthly at Chicago, Illinois for April 1st, 1927. State of Illinois, County of Cook: ss.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared H. S. Card, who, having been duly sworn according to law, deposes and says that he is the Business Manager of The Welding Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, G. H. MacKenzie, Chicago, Illinois; Editor, H. S. Card, Chicago, Illinois; Managing Editor, H. S. Card, Chicago, Illinois; Business Manager, H. S. Card, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) The Welding Engineer Publishing Co., 608 S. Dearborn St., Chicago, Illinois; G. H. MacKenzie, 7131 Crandon Ave., Chicago, Illinois; M. J. Hungerford, 7131 Crandon Ave., Chicago, Illinois.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is _____
(This information is required from daily publications only.)

H. S. CARD
(Signature of Editor.)

Sworn to and subscribed before me this 29th day of March, 1927.
[SEAL.] WILLIAM DERZBACH
(My commission expires April 7, 1929.)

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

For Sale—U. S. and Foreign Patents, of attachment to oxy-acetylene torch, fits any make, cuts any shaped hole, round or square, vertical or bevel. Micrometer adjustment, weight 11½ lbs. Ideal line for light manufacturer. No competition. Address, Paul Orzel, 670 E. 170th St., New York City.

Wanted—The address of every gas and electric welder in the United States. Send them to Knight Brothers, 113 S. Oakley St., Chicago, Ill.

For Sale—Service rights on W. K. and W. C. Prest-O-Lite Cylinders, large or small quantities. Alfred E. Corp., 40 Mathewson St., Providence, R. I.

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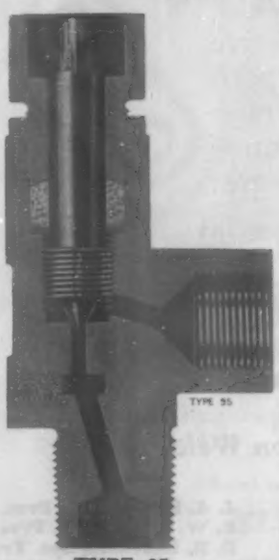

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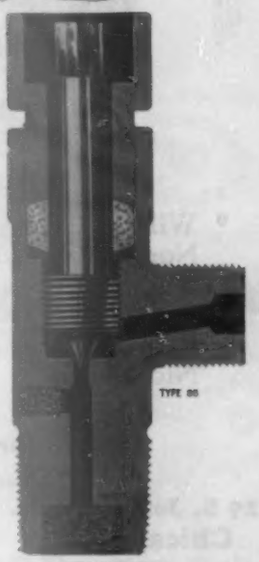

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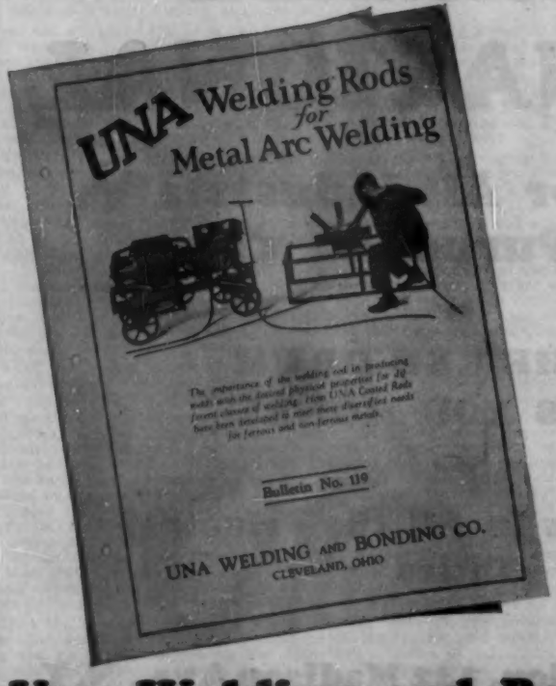

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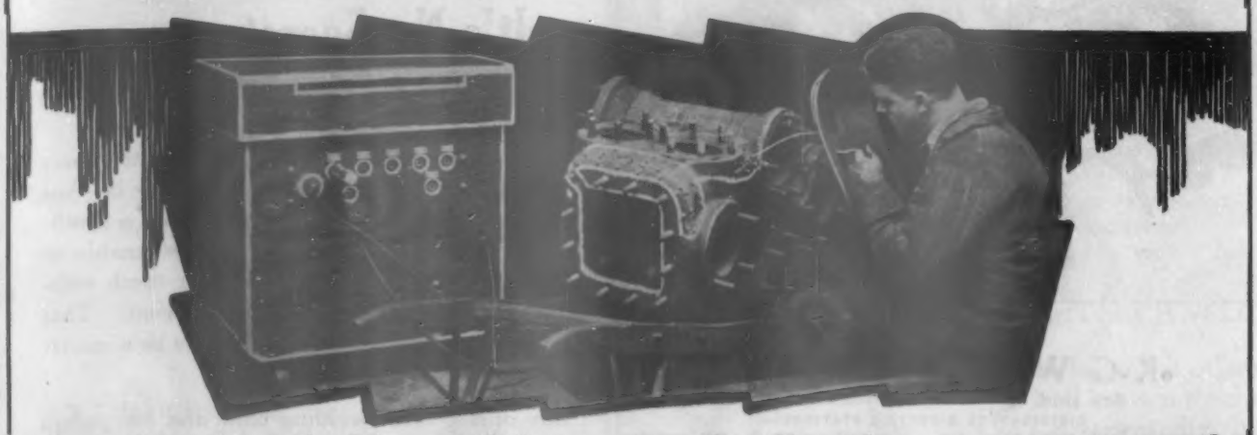

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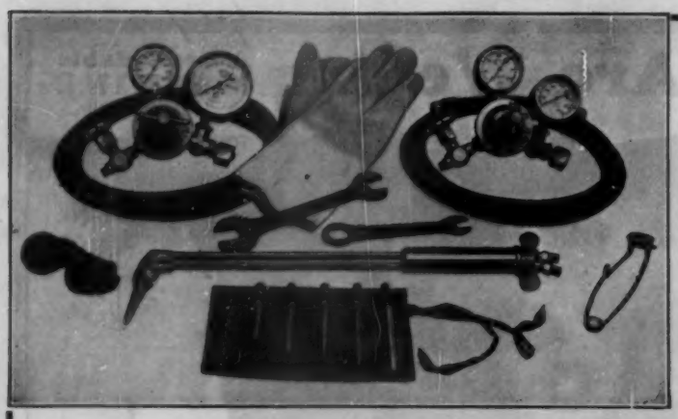

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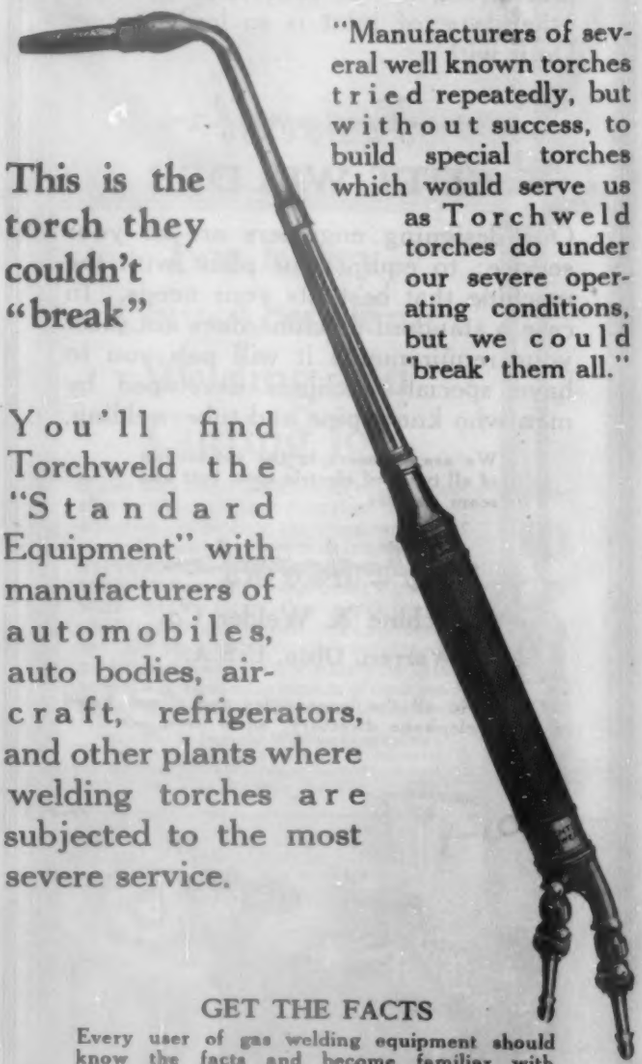

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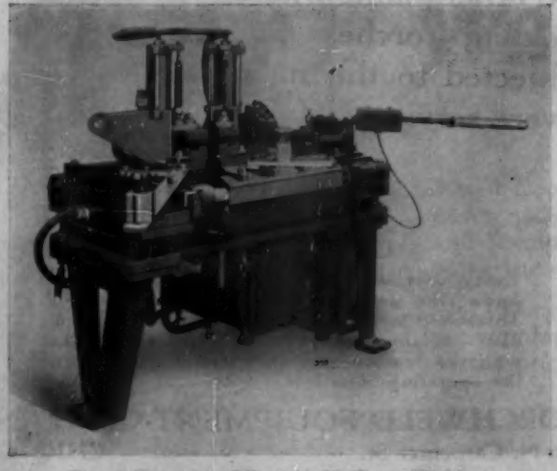

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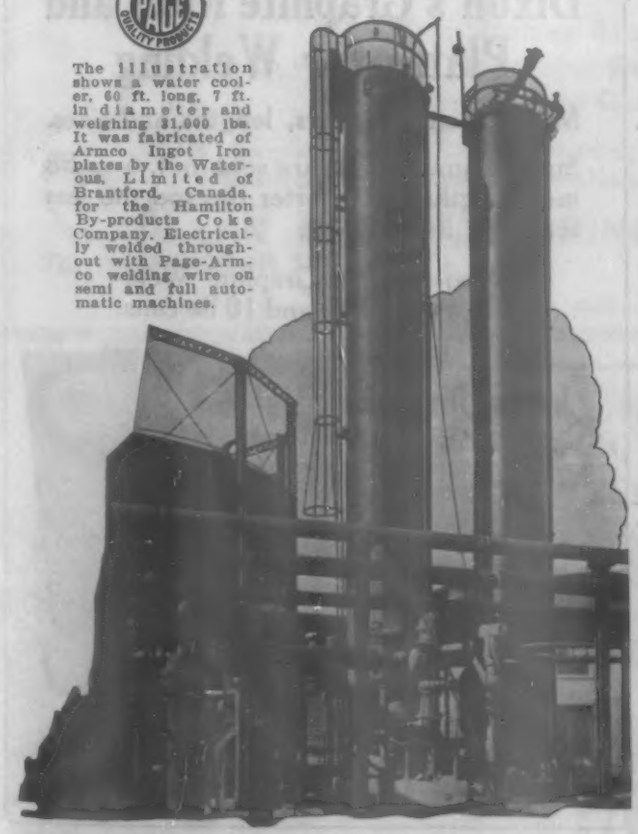

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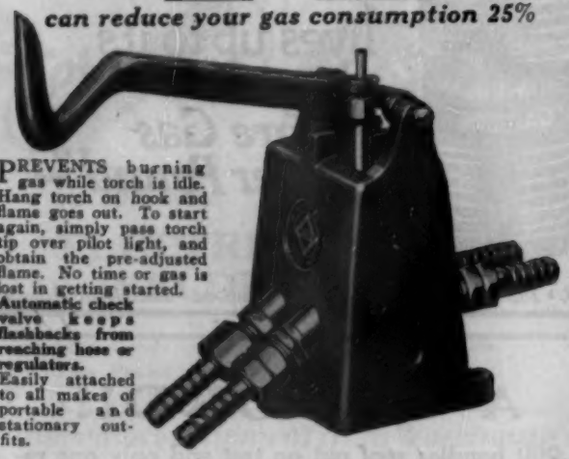

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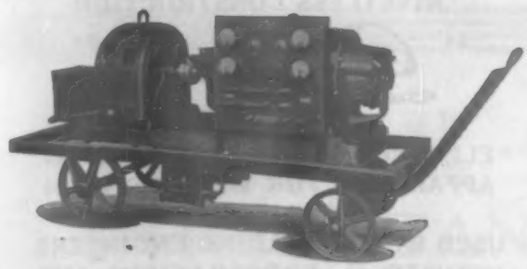

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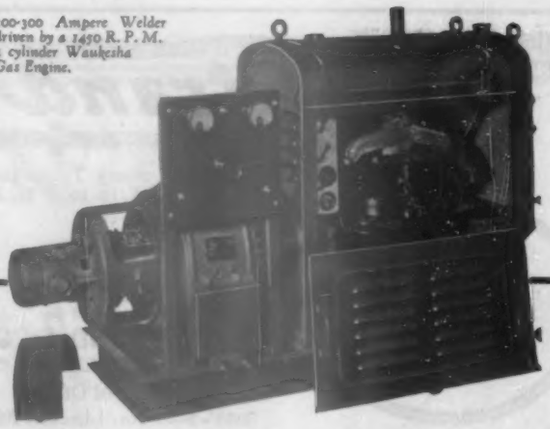

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Our No. 11 Shield, especially for welders who wear correction glasses. You will enjoy the comfort and freedom afforded by it.

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Transmit no injurious radiation
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In addition to our regular stock we have just added the following:
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RESISTANCE WELDING
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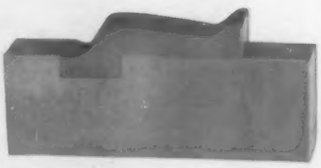

Flash Welding
Automobile Wheels.

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TO	WRITTEN FROM	DATE
Sales Department	Engineering Department	April 15, 1927
		DICTATED BY J.A.W.
ATTENTION	SUBJECT	COPIES TO
G.M.S.	Recommended uses for Elkonite Resistance Welding Electrodes	

(1) Flash welding. For facing flash welding jaws and dies Elkonite is used approximately 5/8" to 1" thick. It has been so used now for more than a year on practically all the machines of the automobile wheel manufacturers, giving a life from 15 to 30 times that of copper.

(2) Non Ferrous Metals. (a) At present Elkonite is being used in one of the largest automobile factories for spot welding brass radiator shells. 400,000 welds are obtained here, with Elkonite against 16,000 for hard drawn copper. (b) Several large aluminum plants have tested and found Elkonite satisfactory for direct spot welding aluminum, and have been using it for this purpose for more than a year. With Elkonite, aluminum can be spot welded without the use of steel shims, and the welds are sound and without the usual pinholes.

(3) Electrical Upsetting of Rivets. Elkonite Grade 30 W 25 is now being most successfully employed in this work. On one job alone Elkonite operated on 7 machines is recording savings of $2.00 per day per machine.

(4) Cross Wire Welding. In use for this purpose in numerous places, with great success. One job is showing 225,000 welds with Elkonite as compared with 15,000 with hard drawn copper.

(5) Projection Welding. Where the projection method is used Elkonite is not only far superior to copper but in several instances has made possible the substitution of automatic for manual welding.

(6) Spot Welding. (a) For spot welding steel 5/32" or thicker Elkonite pads are now very generally being used with success and economy. On one job they are still operating after 2 years ..... 20 times the life of copper. (b) For spot welding thin gauge metal 1/64th to 5/32" thick the electrodes are silver brazed inserts in the regular copper electrodes, the inserts having 1/2 the diameter of the copper point.

Please advise if you wish additional data.

J.A. Welger

Projection welding.
Two projections welded
simultaneously.

Descriptive data sent
on request.

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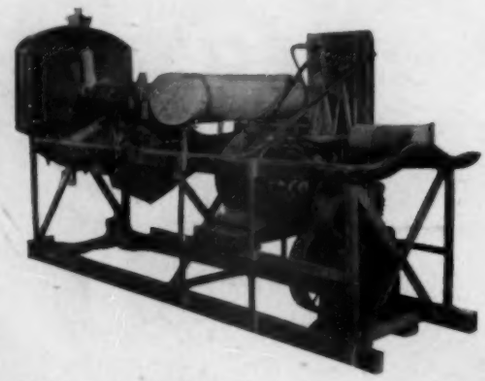
Weehawken, N. J.

Exclusive licensees under General Electric Co., patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works, Inc.

The Right Combination for Every Welding Job



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Gas Engine Welder and Power Plant For Outside Work

and the

"ALTERNARC"
For job welding and wherever electric power is available

Walt the Welder says:

"When you are buying arc welding equipment there are some points to bear in mind, such as:

1. Is the manufacturer reliable?
2. How long have they been in business?
3. Do they manufacture welding equipment exclusively, or is it to them 'just another line'?
4. Just what type of machine would be best suited to the requirements of my work?
5. What is the first cost?
6. What will be the maintenance cost?
7. Will I get real service?
8. Will I be considered a friend or just a buyer?"

We have manufactured electric arc welding equipment exclusively for over ten years, our line including every type of arc welding machine known

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